

**Exploring Lebanese Teachers' Engagement in a Low-Cost, Technology-Enhanced,
Problem-Solving, Orientated Learning Intervention with Refugee Children**

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June 2022

Declaration

I, Eliane Metni, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

Personal Statement

I dedicate this research to, Marc, Paul, and Christian who encouraged me to pursue and sustain my work over the many years, particularly when life became challenging, to my colleagues at the International Education Association for their commitment to the work we are doing, to the teachers who invested themselves and continue to do so, to the volunteers who supported the workshops and to all the students – Lebanese and Syrian refugees – for their enthusiasm and work. I am also deeply appreciative of the continuous support and guidance my advisor has provided me during this long journey.

Thank you to all my family and friends for their support, for hosting me when I needed it, and for their interest in my work. I wish Mariella could read it now so that she could understand why I have chosen this road.

Impact Statement

The research contributed meaningfully to knowledge, professional practice and to addressing the problem of teachers' capacities to enhance the learning of displaced people or refugees in challenging contexts. Acknowledging that this research is a learning process, it has enabled me to theorise and research how teachers learned in the Creative Process. It has also enabled me to examine and question the International Education Association organisational strategy and theory of change. Building on lessons learned from this research, the organisation is currently planning a second phase to scale the intervention with the Ministry of Education and Higher Education (MEHE) in Lebanon...

Abstract

The research explored what learning was fostered when 41 Lebanese teachers from 21 schools engaged in a low-cost, problem-oriented, technology-enhanced situated learning intervention with refugee children to understand teacher agency in practice within challenging contexts. The research is at the intersection of pedagogy, technology, curriculum, and teacher professional development, and explored a situated teacher professional development (TPD) intervention in the context of refugee education. The low-cost technologies utilised in the intervention share similarities with those used in maker-spaces and are taught within a pedagogical process rooted in knowledge-building in the real world. The research is informed by complexity thinking, socioconstructivist, and interpretivist epistemologies and underpinned by a conceptual framework drawing on Mezirow's transformative theory and Habermas's (1985) communicative action around teachers' lifeworld (subjective, objective, and social) as a shared experience. Conversations around teachers' lifeworld draw on Laurillard's conversational framework to help teachers design projects through experiential and discursive conversations. Qualitative data was collected through interviews and observations which were analysed thematically using Pachler et al.'s ecological sociocultural framework. The research adopted an understanding of agency as situated, temporal, and rooted in teachers' past, present, and projected future experiences, drawing on Giddens' structuration theory. Teacher agency in practice appeared as ecological, temporal, complex, and intertwined in dialectic relationships around emergent knowledge-building pedagogy, between collective and individual dimensions in the situated intervention, and in actions driven by moral values, in school and in the community. The research revealed that situated transformative TPD models can be used even in challenging, post-conflict contexts and may contribute to generating contextually relevant solutions.

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1 Introduction

1.1 Background

Education is a basic right of all children and a necessity for young people to build their futures, live a productive life, co-exist, and contribute to society. However, the problem of access to education has become a challenge for millions of refugees and displaced people around the world (United Nations High Commissioner for Refugees [UNHCR], 2019a). Globally, nearly 25 persons are forcibly displaced every min (UNHCR, 2020 and out of the 79.5 million people who are forcibly displaced, 26 million are refugees (UNHCR, 2019a).

In Syria, since the beginning of the war (2011), education has increasingly become a societal issue and a generation of Syrian children have had their formal education suspended. The Syrian conflict has directed international and local organisations' attention to the "lost generation" of school-age Syrian refugee children (UNHCR, 2014a) whose education was referred to as being central to the problem rather than a side-issue in humanitarian plans (UNESCO 2017b). The impact of the Syrian conflict is massive with over 6.5 million displaced people (UNHCR, 2020). It has created 4.2 million refugees and rendered 18 million people in need of humanitarian assistance, 8.1 million of whom are children and 5.7 million of them in need of education (UNHCR, 2020).

With a population of 6 million people, Lebanon holds 1.5 million refugees, principally from Syria, and more than 470,000 Palestinian refugees (United Nations Relief and Works Agency [UNRWA], 2015) who have been displaced since 1976 (UNESCO 2017b). This means that 25% of Lebanon's population are refugees, making it the country with the most refugees in relation to its population (UNHCR, 2020). This is particularly daunting, not only because of Lebanon's limited resources to cater for the children of the 1.5 million refugees, 35% of whom are between five and seventeen years of age, but because it is a brittle educational system that already needed reform (Ministry of Education and Higher Education [MEHE], 2014).

1.2 Research Rationale

At the start of this research (2016), the response plan to the education crisis in Lebanon focused on providing access to the large number of children that were out of school (MEHE, 2014). In 2014, the United Nations called for \$1.89 billion to support Lebanon in dealing with the refugee crisis, out of which Lebanon received \$242 million in 2014 (UNHCR., 2014c). Support grew incrementally in subsequent years (United Nations Educational, Scientific and Cultural Organization [UNESCO], 2019) and the United Nations agencies, the United Nations Children's Fund (UNICEF) and UNHCR, led such efforts providing support to the Ministry of Education and Higher Education (MEHE, 2016) which mainstreamed refugee education under MEHE's Project Management Unit (PMU), the emergency response arm of the MEHE (MEHE, 2014, 2016). The PMU works directly under the Minister of Education and is responsible for all education interventions related to the Syria Crisis (MEHE, 2016). With the aim to include as many children as possible in public schools, MEHE opened its doors to Syrian children (MEHE, 2014). The Public Response of the education sector (MEHE 2015, 2016) provided support to those out of school through non-formal education programmes with basic literacy and numeracy (BLN) and an accelerated learning programme (ALP) which aimed to help children who were out of school for more than two years to catch up with the Lebanese educational system (MEHE, 2014; Karam et al., 2017).

Reports around refugee education depict a dire crisis with a lack of capacities and qualified teachers as well as alarming dropout rates (UNESCO, 2019; MEHE, 2014; Buckner et al., 2018, Dryden-Peterson, 2011). Sarah Dryden-Peterson's research was one of the early reports to raise the alarm regarding the lack of teacher preparedness to cope with teaching refugees and the distressing dropout rate of students (Dryden-Peterson, 2011). Subsequent research, surrounding teachers of refugees in Jordan, emphasised the lack of attention teachers have attracted within the field of refugee education (Richardson et al., 2016). The initial response to the Syrian education crisis was argued by academics and professionals to be a

reductionist approach overshadowing basic developmental needs and intercultural dynamics (UNESCO, 2019; Jalbout, 2015; Dryden-Peterson, 2016). Case studies of education in conflicts and crisis emphasise the crucial role of teachers in educational initiatives and projects (Dahya, 2016). Indeed, the role of teachers is most critical at any point in education along the “humanitarian–development continuum” to ensure that children achieve their potential (UNESCO, 2016, p. 58).

With the magnitude of the education crisis, ICT-based solutions were sought to provide access and improve the quality of teaching and learning (World Bank, 2016a). ICT stands for information and communication technologies, as a set of diverse technological tools and resources used to communicate, and to create, disseminate, store, and manage information (UNESCO, 2002). Thus, since 2012, a series of ICT-based initiatives to train teachers and provide Syrian refugees with access to learning have been piloted, tapping into the affordances and potentials of ICT.

The *Landscape of ICT in Conflict and Crisis* (Dahya, 2016) report compiled 83 ICT-based initiatives piloted around the world, encompassing innovations, digital learning, games, digital platforms, digital content, and free educational resources (Dahya, 2016). However, none of the pilots seem to have had a deep impact on refugee learning (Dahya, 2016). Such inconclusive evidence of the role of ICT alone to enhance refugee learning is not surprising and concurs with research evidence surrounding educational technologies in regions of conflict and crisis (Unwin et al., 2017).

As recognised by the Incheon Education 2030 Framework for Action, ICT contributes to universal access, equity, and the delivery of quality learning (UNESCO, 2017a). Nevertheless, it appears rather unlikely that ICT alone could provide a solution, particularly with the shortage of qualified teachers and the complexity of the education crisis. Generally, ICT projects for refugees tend to provide teachers with access to ready-made digital learning solutions; hence, interventions are inclined to teach them how to use such solutions. Of course, one could argue

that it is better to have ICT because at least refugees would have access to digital resources. However, the magnitude of the crisis leaves room to thinking further about what might be possible if the problem were approached with more emphasis on the teaching and learning context and how to make learning more relevant to refugee learners.

Indeed, more general research in the field has shown the complex relationship of ICT with learning and how teachers' use of ICT could promote doing old things in new ways albeit with those old things remaining unchanged (Pachler & Noss, 1999; Selwyn, 2011). This is even more pertinent in a landscape such as Lebanon where teachers have shown a tendency to use ICT to "show and tell", thus reinforcing passive rather than active learning (MEHE, 2012). In other words, there is more to learning and enhancing teachers' practices than just distributing ICT and telling teachers how to use it. Therefore, rather than having teachers and learners consume ready-made ICT-based solutions designed for them, if ICT were coupled with teacher professional development towards more contextually relevant learning, teachers and students could be part of the solution.

My interest in this research is therefore to address the problems of teaching refugees contextually and to explore a different way of approaching refugee education through an intervention with public school teachers in Lebanon. The intervention is designed to engage teachers of refugees in a problem-orientated, low-cost, technology-enhanced learning experience. As will be explained later in Chapter 2, the choice of working with public school teachers is because in Lebanon, the highest number of refugees (73%) live in cities and attend public schools. The proposed intervention is therefore addressed to schoolteachers who teach refugees in Lebanese public schools where most refugees are learning. The research main question and sub-questions are presented next in Section 1.3.

1.3 Research Question

As emphasised in the *World Bank Development Report* (World Bank, 2018a) and UNESCO's *Global Education Monitoring Report* (2019), the literature surrounding Syrian

refugees focused on addressing the problem of access to learning. However, the huge and alarming school dropout rates show that keeping children in school remains a serious problem despite all efforts to provide supporting programmes to help children out of school for more than two years to catch up with the Lebanese educational system (MEHE, 2016; Karam et al., 2017).

In addition, retaining children in school seems to be undermined in reports and is generally overshadowed by the magnitude of the access problem (UNESCO, 2017b) with little attention to the professional needs of teachers and the type of learning taking place in schools hosting refugees (Richardson et al., 2016; Dryden-Peterson 2016). Such a narrow view of the problem, coupled with deterministic views of ICT in learning (Dahya, 2016) sheds light on a gap in the literature around pedagogically driven solutions and has encouraged the pursuit of researching ways to enhance learning in public schools hosting many refugees through a situated technology-enhanced pedagogy.

Thus, the research explores how teachers of refugees in Lebanese public schools may provide learning that is more relevant to refugee children, by exploring what kinds of learning emerge in situated problem-orientated, low-cost, and technology-enhanced learning environments. The intended outcome is a pedagogically driven model and enhanced teaching and learning skills in schools hosting refugees which arguably in the long term will increase school retention rates.

The intervention was conducted in close collaboration with MEHE in Lebanon with funding from the International Development and Research Centre (IDRC), Canada between 2016–2018.

The research for this dissertation is independent from the IDRC research and the question posed is: “What learning is fostered when Lebanese teachers engage in a low-cost, problem-orientated, technology-enhanced learning intervention with refugee children?”

The four sub-questions are as follows:

1. What are teachers’ perspectives on the learning intervention and how does it relate to

their practices?

2. How are teachers experiencing this learning intervention, what is working or not, what tensions are they experiencing, and how are they mitigating them?
3. What was the process like for students to think and create their artefacts and how does it relate to their learning?
4. What value do the artefacts represent to the students, teachers, and principals?

The research question posed is exploratory and investigates a pedagogical approach which is in stark contrast to the current type of teaching and teacher training provided in the context of refugees in Lebanon. The intervention explores how teachers experience a situated teaching experience which aims to make learning a meaning-making experience for refugees.

The seminal work of Dewey (1938) and Vygotsky (1978) in sociocultural and psychosocial pedagogy emphasise learning as an active process of meaning-making. Meaning-making enables making learning relevant to refugees by bringing their own lived reality and experiences, world perspectives, and understanding of themselves into the learning process. Since teaching isn't simply presenting more adequate information in an effective manner, meaning-making is viewed as central to learning and to incorporating students' readiness to learn (Vygotsky, 1978).

Vygotsky (1978) looks at the development of meaning as a process, one that is shaped by its systemic relationship with other psychical functions, processes, structures, and systems. According to Dewey (1938), active participation by students around their experience and worldview are critical to meaning-making. Dewey insists that the "content of the child's experience" is more important than the "subject-matter of the curriculum" (Dewey, 1938, p. 342).

According to Vygotsky (1978), meaning is sociocultural and conveyed through an internal complex system of thinking and speaking which enables children to develop a structure of generalisation to make meaning of the world and their experiences in learning. Underscoring Vygotsky's study of the inter-intra psychological nature of communication, consciousness, and

meaning-making, learners' experience and views of the world are tantamount in Dewey and Vygotsky's theories to foster meaning-making and is a way of recognising learners' voice, dignity, and identity (Dewey, 1938; Vygotsky, 1978).

The intervention aims therefore to reinforce teachers' skills with an approach around meaning-making to help them make a connection with their subject knowledge and the real world by bridging the gap between the rigidity of the formal curriculum and the lived reality of refugees. It is implemented with teachers at intermediary schools in first- and second-shift schools and secondary first-shift schools. First-shift schools operate regular morning sessions scheduled from 8 am to 2 pm. Second-shift schools offer sessions from 2 pm to 6 pm for Syrian refugees. The selection of schools is explained later in Chapter 4; however, it is important to note that at secondary level, refugees are only learning in the first shift while at the intermediary level, they attend first and second shifts.

A typical question that arises is "Why are there no second-shift schools for refugees at secondary level?" Arguably, the main reason could be the low retention rates which leaves too few Syrian refugees within the system interested in pursuing their education at secondary level. While the attempt is not to answer this question, my research emphasises the complexity of the sociocultural learning environment where the research took place. It also justifies why exploring a different approach to teaching and learning designed around generating meaning-making is vital in this context.

The first and second sub-questions seek to understand teachers' experience. Primarily, the questions aim to comprehend the process that is taking place as teachers experience a different pedagogical approach, how they are able (or not) to implement it, what is working (or not), and how they are facing and mitigating challenges. The process will enable an understanding of teachers' agency in practice, how it is manifesting itself, what actions they are taking, what is driving those actions, what is constraining and enabling them, including their beliefs, assumptions, and values.

The third and fourth sub-questions enable an exploration of the learning that emerges with students, how they experience this way of learning, and what it means to them. Looking into children's learning aids an understanding of the relationship between teaching, learning, and the meaning-making process. Nevertheless, the focus of the research is on teachers' experience and the learning that emerges since teaching is closely tied to learning. The research focuses on the context of learning which, as explained later in chapter 2, ascertains the importance of digging further into the sociocultural realities of Syrian refugee learning in Lebanese schools.

1.4 Timeliness

The UNHCR (2019c), UNESCO (2019), and World Bank (2018a, 2018b) reports emphasise the importance of addressing the problem of refugee education considering the surge in the number of refugees and forced migrants which continues to be a massive global problem. Indeed, the numbers of forcibly displaced people at the end of 2020 reached 82.4 million people (UNHCR, 2019c). The problem we are witnessing as explained by the High Commissioner for Refugees, is a changed reality in that forced displacement nowadays is not only vastly more widespread but is simply "no longer a short-term and temporary phenomenon", (Filippo Grandi, UN High Commissioner for Refugees (UNHCR, 2019c p.4).

As mentioned earlier, recent research highlights the gap in refugee education and reiterates the dire need to better understand teachers' needs and experiences and the utmost importance of building teachers' capacities (Richardson et al., 2018; Buckner et al., 2018). Thus, the research is timely, considering the growing global problem of refugees' education, the lack of attention given to teachers, and their central role and influence on refugees' learning.

1.5 Professional Interest

My interest in exploring this question builds on previous experience with teachers in the context of the refugee crisis in Lebanon and work conducted by the International Education Association (IEA), the organisation that I work for.

IEA is a Lebanese-based non-profit organisation with projects in 40 countries and over a decade of experience in teacher professional development in challenging contexts, such as Yemen and sub-Saharan Africa. IEA's vision is to engage educators and youth in quality, inclusive, creative, and collaborative learning, making use of digital technologies through projects that contribute to a more humane, inclusive, and equitable world.

IEA's core work is with educators as it believes that high-calibre teachers are a fundamental necessity for achieving quality education for all children and that empowering, upskilling, and supporting their development requires urgent attention. This is valid, not only because there is a shortage of qualified teachers resulting from the Syrian education crisis, but because of the "equity gap in education resulting from the uneven distribution of professionally trained teachers, especially in disadvantaged areas" (UNESCO, 2015 p.54).

IEA's teacher interventions are experiential courses with hands-on projects, designed to strengthen mainstream learning and to enable teachers to organise project work around their learning goals. In Lebanon, IEA's interventions are conducted in close collaboration with the Ministry of Education as co-curricular activities aligned with the national curriculum. The term "co-curricular" is used to emphasise that projects are designed to strengthen formal learning as compared to extra-curricular activities that generally refer to after-school clubs or programmes. Using co-curricular projects to enhance teaching and learning allows IEA to be in a space that is neither in nor out of school, and allows teachers to integrate projects into practices, without disturbing the organisation of learning in a school.

In designing its interventions, IEA upholds UNESCO's Sustainable Development Goals (SDGs) with an emphasis on SDG 4 (UNESCO, n.d.) which aims to "ensure inclusive and equitable quality education and promote lifelong learning opportunities for all" (UNESCO, n.d.). According to the Incheon Declaration (UNESCO, 2015), which was adopted by member states in 2015, quality education fosters, "creativity and knowledge, and ensures the acquisition of the

foundational skills of literacy and numeracy as well as analytical, problem solving, and other high-level cognitive, interpersonal and social skills” (UNESCO, 2015, p. 8). The Incheon Education 2030 Framework for Action (UNESCO, 2015) provides a roadmap for achieving SDG 4 and explains the interrelationships between seven outcome targets (UNESCO, 2015) and three implementation targets. Of particular interest to IEA in designing its project are targets 4.7: Citizenship education for sustainable development, 4.5: Gender equity and inclusion, and 4.4: Relevant skills for decent work because they provide a framework that is centred around values, that help learners contribute to the community and the environment that they are living in and focus on the acquisition of knowledge and transferable skills to build their future (UNESCO, 2015).

In accordance with SDG 4, and the interrelationships between the SDGs, IEA designs projects that incorporate technological skills in holistic learning that is authentic, situational, and relevant to the needs of learners. IEA’s model is holistic in the sense that it interrelates human, social, cognitive, cultural, emotional, ecological, and technological skills with the SDG values of inclusivity and sustainability. Those interrelated connections are at the core of IEA’s teacher interventions, which are designed to run alongside the academic year to provide teachers with ongoing support when they plan and implement projects with their students.

IEA interventions combine face-to-face training days with online support; those generally consist of six days, which span over two academic terms to allow time for teachers to implement projects in their classroom. Learning combines pedagogy and technology in contextual settings, helping teachers to make meaning, connect what they are learning with their teaching goals, and gradually adopt new approaches as they design projects and implement them with their students. IEA’s experience with teachers and preliminary research conducted with Syrian refugees in Lebanon with four non-profit organisations in non-formal learning (Hawker, 2015) indicates that the impact of IEA interventions has the potential to change old ways of teaching:

The impact of the programme on the teachers, which extended well beyond their work with these children, indicates that it has the potential to transform pedagogy on a much wider scale. (Hawker, 2015, p.12)

In addition to its impact on teachers, IEA projects have deeply impacted students' learning with signs of motivation, less violence, and more social cohesion amongst the student population (Tawil, 2018). Those are important in the context of refugees living and learning in Lebanon as school-based violence was a significant challenge for teachers as reported in the Lebanon Reaching All Children with Education (RACE) II report (MEHE, 2016). Furthermore, in general, students who partake in IEA projects appear to be more confident, responsible, and autonomous learners (Hawker, 2015; Tawil, 2018).

These results are worth exploring as they contradict reports of violence in Lebanese schools and general xenophobia and racism towards refugees (Shuayb, 2020). While the results seem promising, they are not yet published, and IEA's professional interest is to produce and share its knowledge drawing on the available evidence.

Considering the extent of the education crisis and the positive impact of IEA projects on participants, it would be of added value to contribute to the field of refugee education, particularly in the complexity of the Lebanese context as will be explained in Chapter 2.

2 The Context

The context of the research is Lebanese public schools hosting a high number of refugees. This chapter, therefore, provides background information about refugee education, challenges inherent in the field, and its complexity in Lebanon.

2.1 Refugee Education Background

Although refugees and mass displacement are historic phenomena, it is only after World War II that the scale of the disaster, 40 million refugees in Europe only, was such that international law and international organisations were tasked to deal with refugees (Chalabi, 2013). The cornerstone of changes of refugee rights came about with the Universal Declaration

of Human Rights (1948) which was followed by the Convention Relating to the Status of Refugees (1951) as referred to in Appendix A. In 1950, refugee education became the remit of UNHCR, and the field evolved to become the foundation that is still relied upon today. In addition to being underresearched, refugee education is underresourced, receiving the lowest of all sectors with 3% of humanitarian aid allocated to education and only 38% of its requests for funding met (Dryden-Peterson, 2011, p. 3).

2.2 The Status of Refugees in Lebanon

Lebanon hosts over 1 million refugees, yet surprisingly, it is not a signatory of the 1951 Refugee Convention nor the 1967 Protocol granting equal refugee status to all refugees (UNHCR, 2010). On the contrary, the Lebanese government decided to withhold refugee status from Syrian refugees (Ratification of International Human Rights Treaties Lebanon) putting the Lebanese Ministry of Education and Higher Education in a complicated situation. This is opposite to most governments around the world, who observe and abide by the United Nations conventions, and contradictory to policies surrounding refugees and human rights. For further background information about those conventions, refer to Appendix A. In counterpart, Lebanon signed a Memorandum of Understanding (2003) with UNHCR, enabling Syrian refugees to register with the UNHCR (UNHCR, 2006). By doing so, Lebanon shifted the responsibility of refugees towards UNHCR (UNHCR, 2019a, 2019b). Thus, Syrian refugees in Lebanon are referred to as “displaced” rather than refugees.

Furthermore, the case of Syrian refugees is quite unique because of the bilateral agreement (1993) between Syria and Lebanon, based on which, Syrian nationals continued to have the freedom of stay and work (ILO, 2013). Allowing Syrian refugees to work in Lebanon took its toll on education, as it prioritised livelihood over education. It meant that families often relocated because they had to generate income, and that often children worked at a very young age because they had to contribute to their family’s livelihood (ILO, 2013). It further meant that the enrolment of Syrian children is bound to be mobile, temporary, and provisional depending

on where they can generate work to live.

With no specific legislation, refugees still needed to provide legal papers to enrol in Lebanese schools. This requirement represented a major barrier for enrolment at the start of the crisis since many had fled Syria without any of their belongings, and this was reflected in the low level of enrolment in 2014 (MEHE, 2014). At the start of this research in 2016, out of 489,000 school-age Syrian refugees registered in Lebanon's public schools, approximately 59% were still out of school (MEHE, 2016).

The numbers were staggering, with 498,000 Syrian children outnumbering by far the 249,000 Lebanese students in the public system (MEHE, 2016). With the risk of a system not serving its own population and a shortage of qualified teachers, the MEHE faced a staggering dropout rate, not only for registered refugees, but Lebanese students too – numbers declined from 249,000 to 238,000 students (MEHE, 2014) – who despite economic challenges shifted their children from public to private schools (Buckner et al., 2018; MEHE, 2014). Those shifts were explained as xenophobia of the Lebanese towards Syrians (Shuayb, 2020). In addition, at the beginning of the war in Syria, the flood of Syrians coming into Lebanon reminded the Lebanese of the Syrian occupation of Lebanon which began in 1976, during the Lebanese Civil War (1975–1990). The Syrian occupation of Lebanon lasted until 2005 and ended following the assassination of former Lebanese Prime Minister Rafic Hariri (University of Central Arkansas, n.d.).

In response to those challenges, MEHE developed the Reach All Children with Education (RACE) II Strategic Plan and opened 230 afternoon second-shift schools. Refugees already registered in the morning first shift continued learning with Lebanese students, while second shifts were for refugees only. RACE II builds on RACE I, with a more tactical approach to the education sector for 2017–2021, based on the premise of a stabilisation and development agenda, prioritising quality and inclusive education aligned with the fourth Sustainable Development Goal – Quality Education (<https://en.unesco.org/node/265600>; MEHE, 2016). A

summary of the RACE II approach and SDG4 is included in Appendix B for reference.

2.3 Access and Retention

RACE II reports that the enrolment rates of Lebanese children into public school returned to pre-crisis levels and over 42% of compulsory school-age refugee children received certified education despite significant documentation barriers (MEHE, 2016). However, with the scale of the problem, providing access has overshadowed retention (World Bank, 2018a, 2018b; UNESCO, 2019). Though significant, such barriers overshadow deeper and less apparent issues alongside challenges of refugee education as explained next.

Indeed, documentation requirements were waived for Syrian children (MEHE, 2016) by removing the main barrier to enrolment of refugees in public schools, which increased from 27,000 (25% in the 2011–2012 school year) to 103,000 (50% in the 2013–2014 school year). The enrolment of refugees in schools varied per region with an average of 35% of refugees attending first-shift classes with Lebanese students, while the remaining 65% attended second shifts (MEHE, 2016). However, although school enrolment of refugees increased, dropout rates remained concerning (MEHE, 2016) with an even lower quality of learning in second shifts, unprepared teachers, and a reduced schedule from six to four hours per day (MEHE, 2016).

Reports reveal a decreasing number of refugees per higher grade levels, with only 1,085 registered refugees in Grade 9, as compared to 29,348 in Grade 1, 13,302 in Grade 4, and 7,900 in Grade 5 (MEHE, 2014). At the start of this research, those alarming numbers persisted, with no refugee student registered in afternoon shift schools. Thus, secondary-aged refugee students who were registered in Lebanese schools were learning in first shifts only, or were not in the system at all (MEHE, 2014, 2016).

Generally, reports around refugees in Lebanon put more emphasis on the number of children out of school than those remaining in the system (UNESCO, 2019). While the rates are not a question of study in this research, they indicate, as stressed by the *World Bank Development Report*, that providing access to education is not enough; children must remain in

the system (World Bank, 2018a). The research argues towards examining a different approach to refugees' school learning and teacher training as will be explained in Chapter 4 on the intervention.

2.4 Quality

The fact remains that despite quality being one of the highest priorities of refugee communities, refugee education is generally associated with low quality instruction (Dryden-Peterson, 2011). Interestingly, King's (2016) report emphasises that 86% of the world's 60 million refugees live in the global South in countries where the quality of instruction suffers from already weakened structures and systems (King, 2016).

This is the case in Lebanon with its fragile education system and spiralling downward Programme for International Student Assessment (PISA)¹ scores, placing the country's school performance among the lowest PISA-participating countries and economies (OECD, 2018). Thus, one of the arguments upheld in this research is towards a different type of learning for the displaced and refugees to generate more interest and motivation to learn, and to increase retention rates. Hence, understanding what drives teacher agency in the context of refugee education is particularly important.

¹ PISA scores dropped with mean scores in reading (353), mathematics (393), and science performance (384) well below the average of 487 in reading and 498 in mathematics and sciences (OECD, 2018).

2.5 Equity

Despite all efforts to allow access to school, policies adopted in Lebanon generated inequitable provision of learning exacerbated by the mobility of refugees. Generally, the enrolment dates for Syrian children in public schools are announced late in September and extended until late December. This affects the whole system with no indication of enrolment numbers until the beginning of the school year. Furthermore, it means a much shorter academic year for refugee children, and increased stress on school staff and teachers who must schedule and organise learning for latecomers. Such inequity is also marked by the difference between first- and second-shift schools, the latter of which are perceived to offer a lower quality of learning, reduced programmes, subjects, and hours (Shuayb, 2020).

2.6 Approaches to Refugee Education

Refugee education is described as complex and fragmented and not easy to synthesise (Rutter, 2006). As explained by Dryden-Peterson (2011), the field is guided by three main conceptual approaches: the “humanitarian, human rights, and development” (Dryden-Peterson, 2011, p.15) as follows:

The *humanitarian* approach was designed on the basis that, sooner or later, displaced people would return home and consider schools as safe places. The approach is guided by the Inter-agency Network for Education in Emergencies (INEE). The *human rights* approach stresses the enabling right to education for all children, under any circumstances, with the purpose of equipping children with the “skills that they need to reach their full potential” (INEE, 2010, p. 7). The *development* approach premise is that the “lack of quality education in crisis would hold back development potential of children and society and recognises the social aspect of education as a long-term investment for society” (Dryden-Peterson, 2011, p.15). These approaches underpin theoretical frameworks that guide the field, namely, the ecological (Bronfenbrenner, 1992), human rights (Fraser, 2003), psychological (Kohli, 2011) and social integration (Ager & Strang, 2008) frameworks, which inform to various degrees, the situated

nature of the intervention. They are briefly explained hereafter:

Bronfenbrenner's ecological framework (1992) recognises the long-term value of education for refugees and for society. It draws on situated and socioconstructive developmental psychology to capture the influence of the environment, or context, on child development (Bronfenbrenner, 1992). Bronfenbrenner's theory postulates that human development unfolds in a nested set of systems – microsystem, mesosystem, exosystem and macrosystem – involving cultural, social, economic and political elements, not merely psychological ones such that the systems and their interactions can nurture or hamper learning (Bronfenbrenner, 1992)

Fraser's human rights education framework (2003) is underpinned by social justice. Fraser (2003) focused on the themes of redistribution and recognition, and recognises refugees as citizens with refugees' full rights representation. The framework touches on policy and wider societal rights, and implies that knowledge-building is also a right for refugees, particularly in learning how to address real-life problems.

Kohli's development framework (2011) focuses on children's psychological needs; Kohli draws on and is guided by children's needs of "safety, belonging, and success" (Kohli, 2011, p. 314). The three indicators are recurrently mentioned in the literature on refugees' education and are part of the intervention to create a context where children feel safe and develop a sense of belonging.

Ager and Strang's social integration conceptual framework (2008) emphasises the role of education as a means for integration into society. They stress the important role that schools play in establishing social relationships supportive of integration, and as places of contact for refugees with members of local host communities. Ager and Strang (2008) draw on Putnam (1993, in Ager & Strang, 2008) and Bourdieu's (Bourdieu & Wacquant, 1992) concept of social capital. They recognise the different forms of social relationships as being influential in identifying assets associated with social connection and trust, that are important for refugees;

namely, social bonds (with family and other forms of group), social bridges (with other communities), and social links (with the structures of the state).

The approaches and frameworks seem clear, yet the transitions between them are not clearly delineated nor well defined; boundaries are blurred and fuzzy, permeable and fluid, within the educational trajectory of refugees (Chelpi-den Hamer, 2011). In fact, the four frameworks inform the intervention, which is situated (Bronfenbrenner, 1992), enabling teachers to create a safe and nurturing context (Kohli, 2011) with enhanced relationships at school and the community (Ager & Strang, 2008); and stressing refugees' rights (Fraser, 2003) to engage in knowledge construction to gain skills for their future.

2.7 Challenges within Refugee Education

2.7.1 Longevity and Location of Refugees

What increases the complexity of refugee education is the longevity of refugees living in host countries and the fact that most of those countries are in the global South. Statistics show that 78% of refugees globally, representing 15.9 million people, live in countries anywhere between 10 and 20 years (UNESCO 2018, p.10), which arguably requires long-term views of education. King's (2016) report shows similar trends, whether in Pakistan, Iran, Bangladesh, Lebanon, Jordan, Turkey, Uganda, Sudan, or Kenya (King, 2016). Thus, this emphasises the seriousness of the problem and the need to consider context-relevant solutions with a long-term view of education for refugees and displaced people to live and contribute to society (King, 2016).

2.7.2 Teacher Readiness and Capacity Building

Reports stress that generally, teachers of refugees (Rutter, 2006; Hamilton & Moore, 2003) internationally, not only in Lebanon (MEHE, 2014; Dryden-Petersen, 2016; Shuayb, 2020), lack preparation to address the challenges that surface with teaching refugees in schools. In Lebanon, teachers of refugees in public schools are the same Lebanese teachers who teach in the public system, with approximately 50% of them working in first and second shifts, which makes their working day very long (MEHE, 2016). While there are no statistics, most of them are contractual teachers, juggling packed schedules, family life to attend to, an economic crisis, and limited time to attend capacity building workshops (Dryden-Petersen, 2016; Shuayb, 2020). Thus, teachers of refugees have the enormous task of coping with time pressures, work overload, and being ill-prepared to create a nurturing context for learning and building relationships of trust with refugees. Further challenges include coping with school violence, bullying, discrimination, trauma, language barriers, and diverse levels in the same class (MEHE, 2016) which are briefly presented hereafter.

2.7.3 School-Based Discrimination

Research on refugee education highlights a host of issues including post-traumatic stress disorders, lack of trust, feelings of depression, isolation, exclusion, and lack of belonging (Rutter & Jones, 1998; Hamilton & Moore, 2003). In addition, refugees in schools must deal with discrimination, marginalisation, fear, violence, and bullying (Pastoor, 2015; Rutter & Jones, 1998; Rutter, 2006; Hamilton & Moore, 2003; Kia-Keating & Ellis, 2007). Reports in Lebanon, similar to postconflict contexts, stress that school-based violence hampers learning (MEHE, 2014; Dryden-Petersen, 2016; Shuayb, 2020; Chelpi-den Hamer, 2011) particularly when refugees and the host society have resentments towards each other. These issues within the structure and system exert pressure on classroom learning and create tensions. These findings ascertain that teaching displaced people and refugees is not a straightforward problem and does not belong to the context of Lebanon alone.

2.7.4 Language and Acculturation

Hamilton and Moore (2003) and Rutter (2006) argue that the acquisition of linguistic proficiency and acculturation are related and may hamper the task of adapting to the culture of the host society (Rutter, 2006; Hamilton & Moore, 2003, p. 53). Language, alongside acculturation, appear as the most significant challenges to address, as they form barriers to refugees learning in the host society (Rutter, 2006; Hamilton & Moore, 2003; Ager & Strang, 2008). Acculturation refers to the changes that occur when two or more cultures come into contact. Rutter discusses at length the notion of “habitus” in acculturation among Vietnamese, Tamil, and Sudanese children (Rutter, 2006 p. 55), as an issue in relation to second language learning.

Indeed, the Lebanese and Syrian cultures are intertwined, yet very different when it comes to school learning, since curriculum subjects are taught in a foreign language. In other words, Syrian children are not learning using their mother tongue, which slows down their learning and, as explained by Rutter, requires additional attention from teachers, extra care, and an awareness of socialisation (Rutter, 2006). Interestingly, despite the reported violence, the language barrier, and having to deal with so many years of missed schooling, Lebanese educators mention that Syrian students are extremely hardworking, respect their teachers, and value learning, which is puzzling considering the massive dropout rate, and the disengagement from learning².

2.8 An Intricate Problem

Eight years on since the start of the crisis, Lebanon finds itself in a protracted situation, with the same unresolved issues surrounding the Syrian education crisis. The intricacy of the problem is that all those issues are layered in an education system that has its own underlying sociocultural, economic, ecological, and political issues. The Syrian education crisis could be

² Consultations, principals, and teachers' group interviews prior to starting the research, 2012

described as a crisis within a crisis, as Lebanon has a long history of conflict, with an education system hampered by its own civil war (1975–1990). These problems have infiltrated the education system, its structures and practices, and hence influence the learning of Syrians in Lebanon. Some of these issues are sensed or lived, such as cultural differences, anxiety, and fear of conflict but they are not articulated, creating a school climate that lacks harmony and cohesion, and hampers learning.

Arguably, Syrian refugees lack a sense of identity and the ability to project a vision of continued learning in Lebanon, because not only does their status not allow them to permanently stay in the country, but they must often work to contribute to the family livelihood, which often entails relocation within cities and remote villages depending on the availability of work.

As explained, teachers are bound by an archaic curriculum focused on content coverage and the drive to prepare students to pass exams. Most of them teach in the first and second shifts, which are marked by notable differences reminiscent of an industrial form of teaching that views students as vessels to fill with content. The presence of Syrian children in Lebanese schools has provoked school violence and discrimination, which teachers were not prepared for.

In addition, teacher training is disconnected from support, and teachers themselves lack professional status within a system that has stopped employing cadre teachers since the civil war. Cadre teachers are full-time employees who benefit from security, while contractual teachers are paid per hour. Aside from job insecurity, contractual teachers have limited hours in a school and tend to teach in several schools to obtain a higher income. The difference between cadre and contractual teachers impacts school life, since cadre teachers remain at school all day, while contractual teachers hardly have time to cover their teaching schedule, before going on to their second job.

UNESCO (2018) report continues to stress that the Syrian education crisis is marked by low-quality, inequitable learning and a series of problems resulting from unprepared teachers

(UNESCO, 2018). Challenges persist with school violence, multi-level learners, language barriers, and cultural differences, low retention rates, and teachers finding it difficult to cope with the situation. The initial response to the Syrian education crisis as argued by academics and professionals is a reductionist approach to learning, overshadowing basic developmental needs and intercultural dynamics (UNESCO, 2019; Jalbout, 2015; Dryden-Peterson, 2011).

In this intricate situation, the second RACE report (MEHE, 2016) appears to stress MEHE's shift from access to improving quality, equity, and inclusiveness of learning for vulnerable Lebanese and Syrian refugees which puts emphasis on the need for a solution that prioritises teachers' learning within the prevailing sociocultural context beyond schooling in a box. Strikingly, the RACE reports seem to evade questions on how and what type of learning is taking place; how teachers of refugees can be better prepared to enhance learning in a context where learning is reminiscent of the industrial age; and what role ICT might play in the process. In addition, the RACE reports aspire to quality, equity, and inclusiveness of learning, without articulating what those really mean, and without providing a roadmap to reach them beyond giving access to schools. Yet these are challenging constructs in and of themselves in a regular context, without the overwhelming problems that exist more generally within refugee education.

The core problem that the research addresses is at the intersection of *pedagogy*, *technology*, *curriculum*, and *teacher professional development*. It explores how teachers may integrate a situated knowledge-building approach to make learning more relevant to children, by engaging them in solving problems of their choice, and relating the underlying concepts within those problems to their curriculum objectives. The proposed approach is intended to strengthen teaching practices in mainstream learning, without disrupting the organisation of the school.

In the case of refugees in Lebanon, it would provide an integrated approach to school learning in contrast to the fragmented and reduced current approach. The use of the word "integrated" reflects a pedagogy that builds on situated knowledge construction and engagement with ICT, in contrast to fragmented solutions, and shows how teachers may bridge

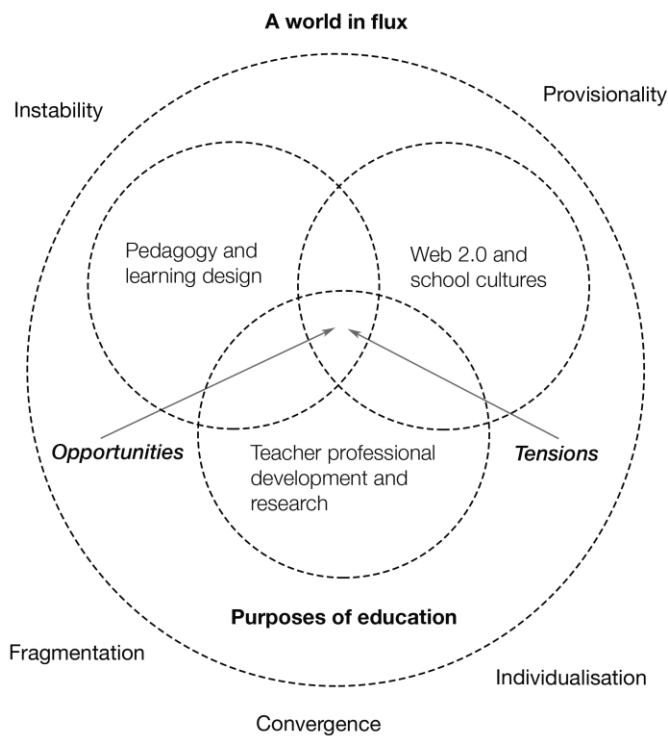
the disconnect between the constraints of a compartmentalised curriculum that simply covers content and the reality of children's lives alongside the problems that this approach provokes in the classroom.

By doing so, the situated approach of the intervention contrasts with “deficit” teacher professional development models, that aim to remedy one aspect of the problem – for example, psychosocial training to counter students' feelings of depression, lack of motivation to learn, or violence (Kennedy, 2014). Additional details of the genesis of the intervention orientation are explained in Chapter 4, explaining pedagogy, technology, curriculum, and teacher professional development.

In this challenging context, the situated intervention is informed by Turvey and Pachler's (2016) “problem spaces” conceptual approach of critical engagement with learning technologies because it helps to frame the complicated relationship between teachers' learning and the use of technology with students in formal contexts while acknowledging the importance of the world around them (Turvey & Pachler, 2016).

Figure 1

Turvey & Pachler (2015) Problem Spaces of Technology-Supported Pedagogy



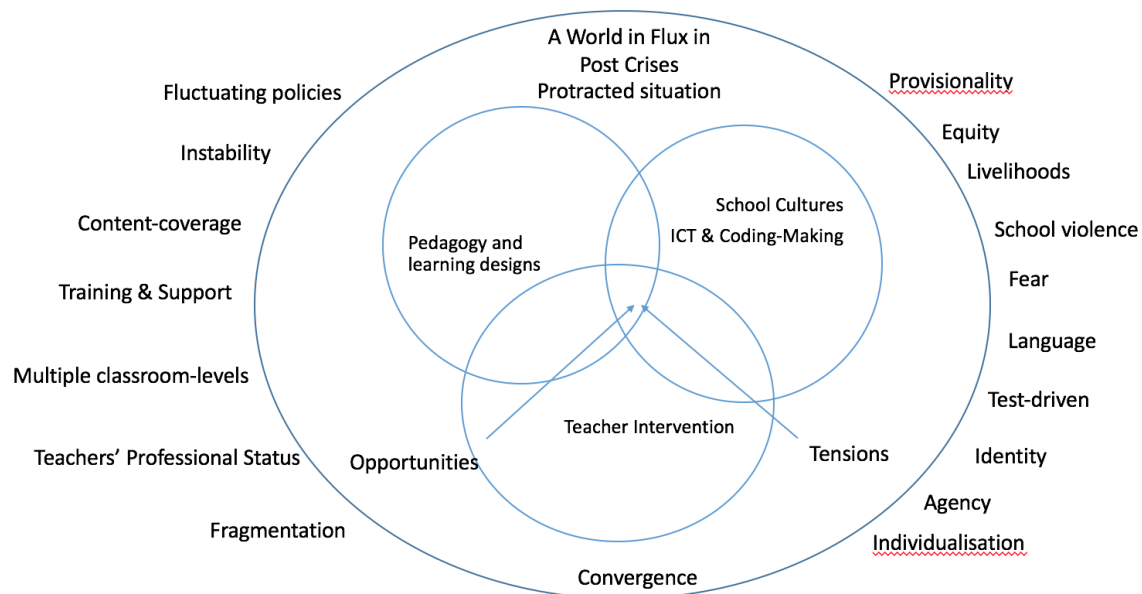
The intervention is designed around the relationships shown in Figure 1 to help teachers design learning that makes meaning within the situation they are living in. In addition to building on the general characteristics of a world in flux such as “fluidity, provisionality and instability” (Turvey & Pachler, 2016), teachers of refugees must deal with the uncertainties of a world in a protracted postconflict situation, and policy tensions around refugees in host countries.

The tensions experienced by teachers of refugees, as outlined in this chapter, are summarised visually using Turvey and Pachler’s (2016) “problem spaces of technology-enhanced learning” representation (Figure 2). As explained, these issues include school violence, cultural alienation, struggles with identity, and a series of inherent issues and policy

inequalities. The intervention recognises these tensions and builds on the opportunities by emphasising teachers' learning and using ICT with the concept of the lifeworld in "collaborative knowledge construction" that is contextualized and "authentic" (Scardamalia & Bereiter, 2005, p 2). Borrowing the term "problem spaces of technology-enhanced learning", the intervention aims to strengthen formal school learning by bridging between, in and out of school learning, without disrupting the curriculum. Thus, Turvey & Pachler's (2016) conceptual approach informs this research, and helps to navigate the intricacy of enhancing teaching and learning for refugees in Lebanon's formal education system. Acknowledging the tensions as described in this chapter reveals the importance of teachers' individual efforts in the process, the support that they need to mitigate tensions, and how to turn tensions into opportunities. Those tensions are presented visually in Figure 2.

Figure 2

Contextual Tensions Presented using Turvey and Pachler's (2016) Problem Spaces Model



The situated nature of the intervention is explained in more detail in Chapter 4, and as

discussed, the interaction has been designed taking into consideration that teachers must mitigate these tensions to adopt a meaning-making process, by incorporating their lifeworld into a problem-orientated teaching approach. In Chapter 3, I consider how the literature justifies the notion of complexity before discussing the literature around teacher agency, teacher professional development, and knowledge-building pedagogy with ICT.

3 Literature Review

3.1 Introduction

The focus of the research is to explore teachers' experiences in a low-cost, technology-enhanced, problem-solving orientated learning intervention with teachers in Lebanese schools that teach Syrian refugees.

The search for literature was conducted using a systematic review of ($n < 10$) academic journals over a period of 5 to 10 years (2010–2020) in iterative cycles. The initial research focused on refugee studies, pedagogy, technology-enhanced learning, and teacher professional development, and grew to include journals around curriculum, migrant education, education research, technology education, and transformative learning; the journals are listed in Appendix C for reference. In addition to peer-reviewed articles, the literature included seminal work around refugee education, namely Rutter (2006), Rutter & Jones (1998), and Hamilton and Moore (2003); social theory, Giddens (1984), Habermas (1985), and Foucault (in Gordon, 1980); experiential and socioconstructive theory, Dewey (1938) and Vygotsky (1978), as well as peer-reviewed articles, conference proceedings, news articles, and technical reports of non-profit associations around refugee education and teachers of refugees.

The literature around teacher intervention, teacher transformation, and agency in practice, in refugee education in formal settings in Lebanon and the Middle East remains scarce. In addition, most articles around refugee school education seem to consider high-income countries, particularly in the field of technology-enhanced learning and teacher professional development (TPD). The literature starts with the notion of complexity and

structuration theory and is presented around the three interrelated elements of teacher professional development, ICT and its affordances, and pedagogy around knowledge-building and constraints as it relates to teacher agency in practice. The literature review ends with the theoretical, conceptual, and analytical framework.

3.2 The Notion of Complexity

As described in Chapter 2, the context of refugee education is complex in a world in “flux”, with massive displacement of people, which explains why postmodern complexity thinking is helpful to research in relation to the teacher intervention. Thus, the attempt is not to theorise complexity but to acknowledge the layers of complexities surrounding learning as teachers’ agency is examined within the structure of professional development to engage teachers in an innovative pedagogical process that draws on knowledge-building with ICT. Complexity thinking rests amongst postmodernist epistemologies and can be described as “a fundamental shift in the way sense is made of our surroundings” (Richardson & Cilliers, 2007, p. 8). Complexity theory lies across the three elements of the intervention, particularly its understanding of knowledge-construction as being emergent (Scardamalia & Bereiter, 2005). Thinking in terms of complexity brings an antithetical stance to instrumental or deterministic views of learning technologies, often predicated on “means to an end”, “best practice”, or “what works” metanarratives (Turvey & Pachler, 2016). It is about making sense of all the interconnections and underlying dynamics, to understand what is at the surface (Burns, 2007).

Drawing on Cilliers’s (1999) view of complexity suits the intervention because his views are embedded in being in the world; complex systems are dynamic and usually associated with living things, “a bacterium, the brain, social systems, language” and thus learning and knowledge-building (Cilliers & Spurrett, 1999, p. 271). According to Burns, thinking in terms of complexity enables an understanding of the emergent properties, qualities, patterns, or structures which arise from the interaction of individual elements (Burns, 2007), which are so important in the sociocultural nature of change. This is echoed by Pachler & Turvey (2016) who

explain that thinking in terms of complexity allows us to recognise the intricate, interlinked, unpredictable nature of learning with digital technologies, and to refute techno-determinism which focuses on narrow measures of gains of attainment (Weston & Bain, 2010; Turvey & Pachler, 2016). Indeed, more general research around learning emphasises the complex relation of education and technology, and avoids simplistic causal and effect approaches or claims that learning can take place in a linear way (Pachler et al., 2010; Selwyn, 2011; Laurillard, 2008). Acknowledging the complexity of those relationships around learning is important and requires a framework to research and analyse them.

3.3 The Mobile Sociocultural Ecological Framework

Arguably, Pachler et al. (2010) provide such a framework by linking *structures*, *agency*, and *cultural practices* which enables an examination of the interlinked relationships around learning with ICT. They explain that the triangular relationships around structures, agency, and cultural practices operate around the learner and are in constant interplay as follows:

- *Structures* are the sociocultural, ICT, and technological structures that govern users being in the world.
- *Agency* is users' capacity to act on the world. Appropriation is argued to sharpen critical educational and analytical perspectives, not only on the cultural practices of everyday life, but also on educational institutions from the perspective of the agency of users, as they form meaning with the use of ICT and by engaging with the wider technological tools embedded in their lives.
- *Cultural practices* refer to the the routines users engage in in their everyday lives, including the use of ICT to communicate in formal and informal learning (Pachler et al., 2010, p. 7).

Thus, the framework will serve as a grid that binds the research elements together as we explore teacher agency in practice; how it relates to the structure of the intervention; to school structures; and how it speaks to teachers' cultural practices, their routines, and systems of

beliefs. While the construct of agency has been widely debated in social theory, it seems much less examined in teachers' practice (Chaaban et al., 2021), and Giddens's (1984) structuration theory provides a foundational underpinning to unveil those relationships.

3.4 Structuration Theory

Giddens's (1984) structuration theory, particularly the dual relation between individuals' agency – known as the capacity to act – and structures enables us to think in terms of complexity to unpack those relations, and to understand the interplay between structure, systems, and teacher agency. Actions for Giddens are motivated and guided by behaviour (Giddens, 1984, p. 181) encompassing a concept of duality between structures and actors who face dilemmas. Such dilemmas include uncertainty and authority, being caught between the local and the global, feeling powerless, individualisation, and being commoditised (Giddens, 1984). These postmodern dilemmas are arguably exacerbated in postconflict situations by issues such as the mobility of refugees and their subsequent fragmented learning experiences in schools, resentment between refugees and host communities, and a general feeling of powerlessness to confront challenges such as classroom violence, discrimination, and acculturation as mentioned in Chapter 2. Giddens (1991) explains that dilemmas often leave actors within everyday teaching scenarios in situations and relationships that reproduce existing social practices. Giddens's duality between structure and actors is about the complexity of those dialectic, interconnected, interdependent, intricate relationships which hold preeminence in promoting new ways of learning, thinking, and doing.

Drawing on complexity thinking and building on Giddens's structuration theory (1984), Morrison (2005) posits that agency and structure inform each other and co-evolve in such a way that individual teachers shape learning, and their practices are shaped by and influence the structures and systems in which they work (Morrison, 2005 p. 316). This process arising from conventional forces in society is explained by Habermas (1985) who distinguishes between three categories of human influence on the structuration process in society: the subjective, the

objective, and the social which the intervention builds on to nurture the dialectic relationships between teachers. This set of relationships influencing and being influenced by teachers could help us to understand how teachers address the constraints of social and school structures, and how they deal with their systems of beliefs, which will be discussed in Section 3.8.3 after reviewing the literature surrounding agency and TPD.

3.5 Agency

Emirbayer and Mische's (1998) seminal work conceptualised agency as "a temporally embedded process of social engagement, informed by the past (in its habitual aspect), but also orientated towards the future (as a capacity to imagine alternative possibilities) and toward the present (as a capacity to contextualize past habits and future projects within the contingencies of the moment)" (Emirbayer & Mische, 1998, p. 963). The approach emphasises the temporal and dialogic process by which agency is achieved as a relation between actors and their social context and structure. As such, an ecological understanding of agency contrasts with earlier theories of agency (Bandura, 2000, p. 75), perceived as efficacy within individuals, impacted by aspirations, opportunities, and a commitment to achieve their goals within their social environment.

Thus, agency is understood "as a human capacity to do and achieve, not a capacity that individuals possess" (Biesta et al., 2015, p. 626). Biesta and Tedder (2007) stress that an ecological understanding of agency has its roots in action–theoretical approaches, particularly those stemming from experiential philosophy (Biesta & Tedder, 2007, p. 11). This capacity to act is emphasised by Pachler et al. (2010, p.4) as the capacity to act on the world, of being in the world, as an ecology, which in turn manifests itself in the form of an emerging cultural transformation. Priestley et al. (2015) explain that this temporal approach is rooted in teachers' past experiences, yet orientated to the future through the setting of goals, and the ability to envisage future possibilities, but acted on in the present (Priestley et al., 2015).

With such an understanding of agency, the question then is, how does teacher agency

manifest itself and how is it triggered?

Pachler et al. (2010) posit that “agency manifests itself as the learner’s social and semiotic capacity, i.e., it is their ability to form relationships with others – mediated by technology – as well as to make meaning and develop representations of the world using a range of sign systems such as language or images” (Pachler et al., 2010, p. 4). Emirbayer and Mische (1998) posit that human agency is triggered when social actors confront problematic situations, which could be compared to Mezirow’s (2000) disorienting dilemmas in transformative experiences (Emirbayer & Mische, 1998; Mezirow, 2000; Terras, 2017). Jones (2020) explains that Mezirow’s transformative experiences are driven by a worldview of orienting assumptions and metacognitive awareness, which transforms an acquired frame of reference in the process of using a prior interpretation to construe a new revised interpretation of the meaning of one’s experience (Jones, in Morley et al., 2020, p. 492).

Building on Emirbayer and Mische (1998), Biesta et al. (2015) suggest that agency is manifested as a configuration of influences from the past, orientations towards the future, and engagement with the present. They refer to these three dimensions as the “*iterational, the projective and the practical-evaluative*” respectively (Biesta et al., 2015, p. 3). Hence, although agency is involved with the past and the future, it can only ever be “acted out” in the present, which is precisely what is expressed in the practical-evaluative dimension (Biesta et al., 2015, p. 4).

Hence, those transformative, ecological, sociocultural, and temporal dimensions of agency are well suited with the triangular relationship of structures, agency, and cultural practices (Pachler et al., 2010). Agency is thus formed and shaped iteratively as users engage in their everyday routines and sociocultural and technological structures, and arguably, it is in problematic situations that people question themselves. As explained by Mezirow, transformation occurs through a disorienting dilemma, leading to a modification of thinking, which drives action (Mezirow, 2000). Thus, it can be viewed as a transformative process of

evolving frames of mind that is iterative over time rather than “a capacity or competence” (Biesta et al., 2015, p. 626).

Finally, the work of Chaaban et al. (2021), Jones and Charteris (2017), and Imants and Van der Wal (2020) emphasise that agency in practice ought to be scrutinised as we know little about how it may be triggered, enacted, iterated, and sustained in practice. Chaaban et al. (2021), for example, examined how teachers’ professional agency in four Arab countries emerged from the need to find solutions during the pandemic. Their study reveals that teacher professional agency in shifting contexts is a fluctuating strength (Chaaban et al., 2021) and is particularly relevant as it reflects the dichotomy between teachers’ agency in practice, classroom decision-making, policy measures, and top-down control constraining agency, encouraging us to look at models of TPD that may enable teachers as transformative actors (Chaaban et al., 2021; Kennedy, 2014).

3.6 Teacher Professional Development (TPD)

The literature examines characteristics of effective and situated models of continuous TPD as it relates to agency and TPD models, drawing on Kennedy’s (2014) classification of TPD.

3.6.1 TPD Focused on Achievements

Although academics contend that effective TPD should harness teachers' practices and provide approaches and content that are contextually relevant for teachers and pupils (Darling-Hammond et al., 2017; Cordingley et al., 2005; Pickering et al., 2007), effectiveness seems associated with political concerns of improvement of achievement and learning outcomes at the classroom level (Hardman, 2012). As emphasised by Darling-Hammond, effective TPD has a focus on enhancing classroom experience, "student outcomes", and "student achievements" (Darling-Hammond et al., 2017, p. 25) within a tradition that builds on TPD being (1) content focused, (2) engaging participants in active learning, (3) collaborative, (4) providing support and coaching, (5) providing time for feedback and reflection, and (6) sustained over time (Darling-Hammond et al., 2017, p. 23).

The argument in favour of effectiveness in TPD seems to strive towards methodological rigour using "experimental or quasi-experimental comparison group, or appropriate statistical modelling and hypothesis testing to estimate the effect of teacher TPD on students' academic outcomes", with controls for context variables and student characteristics to find positive, statistically significant effects of TPD on student achievement (Darling-Hammond et al., 2017, p. 25). Reference to statistical modelling, experimental designs, and studies focused on achievements is made in Appendix D. While these may show results favoured by policymakers, they shed little light on teacher agency, and do not reflect change from the vantage point of teachers. Furthermore, this trend to focus on achievements and learning outcomes seems to establish simple cause and effect assumptions and miss out on a range of socio-cultural gains not always captured by national tests (Cilliers, 1998; Hardman, 2012; Hinostroza et al., 2002). On the other hand, situated TPD emphasises learner-centred, socially, contextually, and culturally relevant learning, building on learners' needs. Cordingley et al., (2005) suggests that TPD that builds a sense of purpose can motivate teachers as actors, and creates a positive professional learning environment with sufficient time and consistency between the professional

learning experience and the wider social and educational context (Cordingley, 2005, p. 5). This resonates with the work of Shulman and Shulman (2004) around what and how teachers learn, which suggests the guiding principles of purpose and moral values in TPD (Shulman & Shulman, 2004).

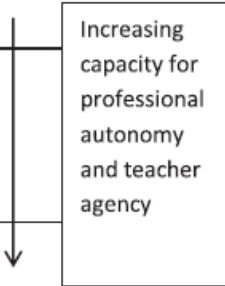
3.6.2 TPD Models and Teachers as Actors

With teachers being central to this research, Kennedy's classification of continuous TPD is useful because it relates TPD to teacher agency and professional autonomy. According to Kennedy, to make real progress towards their professional growth, teachers need to have autonomy and the ability and space to exert agency (Kennedy, 2014). The classification suggests increased capacity for professional autonomy and agency as one moves down the framework categories (Kennedy, 2014). Generally, within the field of education, the concept of professional autonomy is an intricate concept and even more so within the field of refugee education. Thus, we know little about what it might mean for a teacher of refugees to have agency and professional autonomy.

At the risk of over-simplifying the model, Kennedy identified eight models of continuing professional development (CPD) and grouped them into three categories – transmissive, malleable, and transformative – suggesting blurred boundaries within the various models (Kennedy, 2014). The categories are briefly explained following Figure 3.

Figure 3*Kennedy's Spectrum of CPD models (adapted) (2014)*

Purpose of Model	Examples of models of CPD which may fit within this category
Transmissive	Training models Deficit models Cascade model
Malleable	Award-bearing models Standards-based models Coaching/mentoring models Community of practice models
Transformative	Collaborative professional inquiry models



The “transmissive” category includes the training, deficit, and cascade models; the “malleable” category includes the award-bearing, standards-based, coaching/mentoring models, and community of practice models; and the “transformative” category includes a range of collaborative professional inquiry models (Kennedy 2014, p. 693). In addition, the CPD models are grouped with an understanding that often the same professional development might fit into two categories, depending on its purpose. For example, teaching digital skills may fit the “transmissive” and “malleable” category if the training is designed with award-bearing or community of practice features. Similarly, mentoring can be used to support and encourage autonomy, creativity, and independence, but can equally be used to encourage conformity to the status quo (Kennedy, 2014, p. 692). Thus, depending on contingent factors, categories could be viewed as complementary rather than competing, with a range of possibilities between them. The eight models are further explained in Appendix E (Kennedy’s 2014 model) and examples of cascade models are given in Appendix F.

Kennedy's (2014) framework is helpful because it sheds light on important questions, such as who is funding the TPD and what are the TPD's intended or unintended purpose (Kennedy, 2014). The purpose is often overlooked in researching TPD but it is important to understand what motivates teachers to learn or if they are coerced (or not) to enrol in government-prescribed TPD. Furthermore, the framework questions teacher agency in relation to policy, performative ideologies, and perspectives on professionalism. Borrowing Sachs' (2001) term, a managerial perspective on professionalism privileges top-down bureaucratic processes, efficiency, compliance, and externally imposed accountability, while democratic professionalism privileges what Sachs (2003) refers to as activist teachers with more openness, increased collaboration, communication, and agency (Sachs, 2003).

Thus, the relationship of TPD to policy, performative ideologies, and perspectives on professionalism may help to situate the traditions of CPD used in Lebanon. Traditions of effectiveness, cascade models, and managerial professionalism relied upon by MEHE seem to remain dominant, not only in Lebanon but in many parts of the world, such as in sub-Saharan Africa (Hassler et al., 2018; Hardman et al., 2011). These could be problematic, as cascade models can be reduced to a trickle by the time they reach the classroom teacher, on whom agency relies (Hayes, 2000; Hassler et al., 2018; Hardman et al., 2011).

Academics argue that such models can end up in knowledge transmission with passive rote learning and lectures for teachers (Hassler et al., 2018). Traditional cascaded models seem to focus on a concentration of expertise at the top of the cascade (Hayes, 2000) such as in the case of lead teachers in Kenya (Hardman et al., 2011) with significant changes at their level (62%) as compared to (17%) no agentic action for those that were not in the original cascade (Hassler et al., 2018). Researchers studying TPD, school reform, and teacher agency in the school context agree that teachers need to be afforded greater agency (Kennedy, 2014; Chaaban et al., 2021; Imants and Van der Wal, 2020; Jones et Charteris., 2017; Priestley et al.,

2015; Biesta et al., 2015), and that their agency can play an important role in society as a whole and more importantly in challenging contexts (Chaaban et al., 2021).

3.6.3 *Situated Transformative TPD*

The emphasis in situated, action-orientated, and transformative TPD is the belief that teachers are active actors in their own transformation (Riel & Becker, 2008; Laurillard, 2002; Harris & Muijs, 2005; Cordingley et al., 2005; Somekh, 2008) with an emphasis on the iterative nature of professional learning and growth, which seems at odds with effectiveness models (Laurillard, 2002, 2008; Riel & Becker 2008; Scardamalia & Bereiter, 2005; Somekh, 2008).

Research around TPD models suggests that situated experiences that encourage teachers towards “collaborative professional inquiry with an element of problem identification and subsequent activity, where the subsequent activity involves inquiring into one’s own practice and understanding more about others practice” may enable teachers to gradually transform their thinking (Kennedy, 2014, p. 693). Such TPD focuses on teachers’ needs as perceived by them (Pickering et al., 2007), are collaborative, and are aligned with socioconstructive theories, communities of practices (CoPs), (Lave & Wenger, 1991), situated cognition (Brown et al., 1989), and knowledge-building, (Scardamalia & Bereiter, 2005).

Research around TPD that nurtures collaboration between teachers in CoPs emphasises the role of community to promote growth through digital platforms to think, plan, share, and evaluate learning, “placing teachers as experimental innovators and reflective practitioners” (Laurillard, 2008 p. 3) and suggests a positive relationship between collaboration between teachers in TPD and agency (Hargreaves & Fullan, 2012; Lave & Wenger, 1991; Daly et al., 2009; Riel & Becker, 2008; Harris & Muijs, 2005; Fullan, 2001). Studies conducted to measure teachers’ reasoning show that teachers offered TPD alongside ICT that prioritises learning through flexible forms of problem-solving, reflective thinking, and cycles of innovation, as they continuously apply and reflect on learning from their practice, engage in an unimpeded process of growth and transformation (Riel & Becker, 2008; Scardamalia & Bereiter, 2005;

Somekh, 2008). Such TPD evolves from the process of transforming problems of practice into questions, using these questions to shape action, and reflecting on the results to frame new questions (Riel & Becker, 2008 p. 400). The process is constantly evolving such that teachers adapt their practices in continual process of growth as they integrate ICT (Somekh, 2008).

3.6.4 Experiential Learning Theory

Experiential learning appears frequently in the practice of teacher professional development (Smith, 2001), and is used to provide teachers with the opportunity to experience how to problematise what they teach through open-ended problems of practice. Drawing on Dewey's (1938) seminal work and his emphasis on learning from experience, Kolb (1984) claims that Experiential Learning Theory (ELT) is a dynamic and holistic theory of learning a multi-dimensional model of adult development (Kolb, 1984) and proposes cycles of (1) concrete experience; (2) reflective observation; (3) abstract conceptualisation; and (4) active experimentation (Kolb, 1984).

However, Winkler (2001) argues that ELT could be limiting if learners are not able to draw theory from experience. Winkler's experience appears to be relevant as it relates the case of a practitioner providing TPD to teachers with the assumption that teachers will draw theoretical understanding from their experiential work (Winkler, 2001). The challenge seems twofold; firstly, there is the challenge to nurture teachers' reflective thinking despite available strategies, and secondly, to transform experiential pragmatic knowledge into concepts and theories (Winkler, 2001; Greenleaf et al., 2011; Beauchamp, 2009). This concurs with experience and the challenge to help teachers reflect and transform active experimentation to concepts, as will be explained in Section 3.6.5.

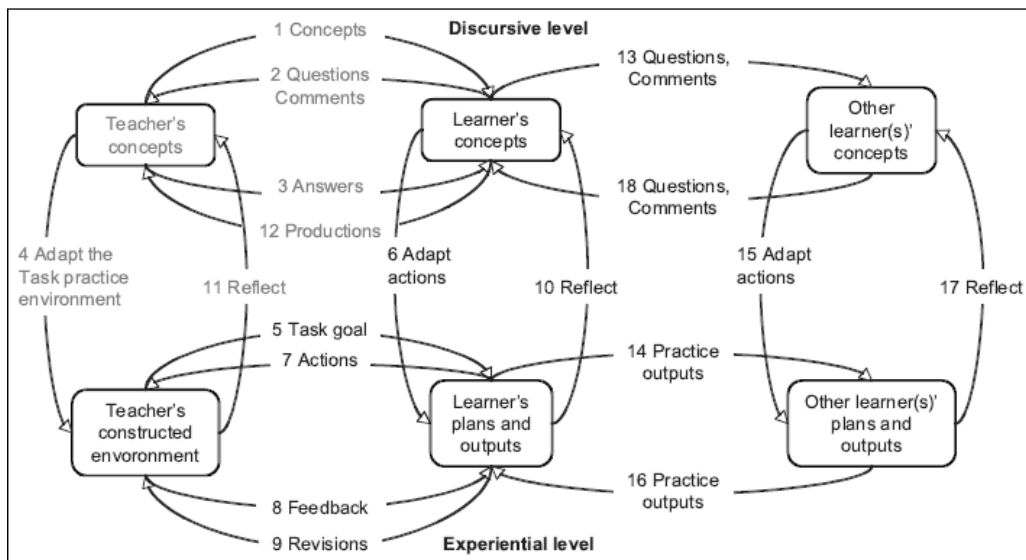
3.6.5 The Conversational Framework

Laurillard's (2008) conversational framework enables such a transformation in TPD through "iterative dialogue" that is "discursive, adaptive, interactive and reflective" (Laurillard, 2008 p. 140). Laurillard situates learning as a relationship between the learner and the world,

mediated by the teacher (Laurillard, 2008). The explicit theoretical grounding of the teaching method proposes to distinguish two different levels of conversations: (a) the “discursive level, where the focus is theory, concepts, description-building”; and (b) the “experiential level, where the focus is on practices, activity, procedure building” (Laurillard, 2002 in Pachler et al., 2010, p. 288). This takes place through communication, interactions, reflections, feedback, actions, and applications in a process that is iterative, as illustrated in Figure 4, which shows the relationship between the discursive and experiential levels (Laurillard, 2008, p. 142).

Figure 4

Conversational Framework (Laurillard, 2008)



Teachers' knowledge as derived from experiential activities may thus surface through discursive dialogue, which is essential in learning, and comprises articulation and rearticulation, by teacher and learner, of theoretical and conceptual knowledge. Laurillard's (2008) framework defines discourse as a learning activity, or a medium that supports learning between teacher and student or amongst students, whereby each interlocuter must be able to articulate a view, re-articulate it in the light of the other's utterance, ask questions, and reply to questions, though

not necessarily synchronously, such as when mediated by ICT (Laurillard, 2002).

The teacher intervention, as described here in Section 4, adapts Laurillard's (2002) conceptual dialogue framework around project work with ongoing shared feedback and reflective processes among teachers, as they conceptualise learning and tie in their objectives, personal, and social worlds. Laurillard's Conversational Framework (2002) provides a base for the cyclical learning process which explicitly relates experiential to conceptual learning, enabling teachers to transition from activities to designing projects. Drawing on Laurillard's (2002) conversational theory, Lee (2006) posits that, as opposed to the ecological stance taken in this research, it is the interaction between people that generates agentic discourses and positions them as 'active agents' in their own learning, enabling them to transform experiences into academic learning through discursive (theoretical descriptions) and an interactive level (application of theory to task) (Lee, 2006). The "discursive level comprises the articulation and rearticulation by teacher and learner of theoretical and conceptual knowledge" (Lee, 2006, p.3) and the adaptation of Laurillard's conceptual framework (2002) in the Creative Process is presented in Figure 5.

Such an explanation of agency stresses teachers' individual action as opposed to the ecological, situated, and temporal understanding of agency adopted in this research. However, this suggests that there could be a relationship between the two understandings of agency and indicates a gap in the literature as to what might that relationship be.

Figure 1

Creative Process Conversations builds on Laurillard's Conceptual Framework (2002)

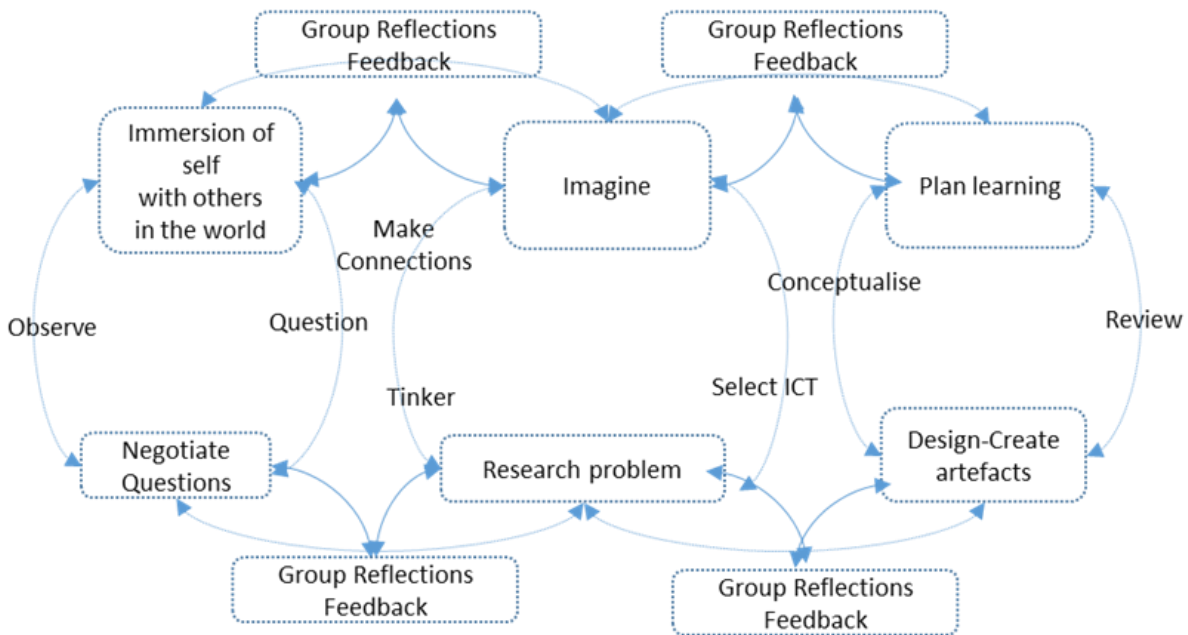


Figure 5 shows the interactions and conversation during the six phases of the intervention. Teachers start in small groups to observe their surroundings. They become immersed in the world, question themselves, and come back to the larger group to reflect on and negotiate questions. They transition to the next phase once they have articulated questions and start researching and making connections to what they are teaching. In the meantime, they tinker with the ICT and continue to investigate the problem and explore the concepts in the problem. They consider and imagine solutions and select the type of ICT they might use. They conceptualise and plan learning based on the problem-solutions and design artefacts, which are created and reviewed after testing them. The arrows around the process and the group reflections on the four ends show the flow of conversation between individuals in teams and the larger group.

3.7 The Pedagogy

The pedagogical process builds on socioconstructivist theory (Vygotsky, 1978) and Scardamalia and Bereiter's (2006) theory on knowledge-building with ICT. Scardamalia & Bereiter (2005) connect knowledge-building to innovation and the skills needed for the future around six tenets: (1) knowledge as a community advancement; (2) knowledge advancement to improve ideas; (3) "knowledge of" in contrast to "knowledge about"; (4) discourse as collaborative problem-solving; (5) constructive use of authoritative information and; (6) Understanding as an emergent goal (Scardamalia & Bereiter, 2005). Knowledge-building, as explained by Scardamalia and Bereiter, ties knowledge-building to the skills needed for the future and builds on the concept of emergent goals. It is an approach to learning that engages learners together in using their knowledge in new, complex, and real-life situations. Building on the six tenets as explained by Scardamalia and Bereiter (2005) requires a shift from treating students as learners and inquirers to treating them as members of a knowledge-building community who think critically and act flexibly with the knowledge they have acquired in the outside world. Scardamalia and Bereiter (2005) six tenets are summarised as follows:

1. *Knowledge as a community advancement* in contrast to knowledge as individual achievement. It is based on the premise that authentic knowledge-building can take place in school classrooms. It emulates the work of mature scholars, and substantively advances the state of knowledge in classroom communities, situating it within larger societal knowledge-building efforts.
2. *Knowledge advancement to improve ideas* rather than progress towards an absolute overarching truth. This is explained in terms of preconceived ideas whereby knowing reaches a final state, while in reality knowledge advances theoretically and historically, always raising new problems and opening up new possibilities, just as do advances in technology.

3. *“Knowledge of” in contrast to “knowledge about”*: in knowledge-building, students work with problems that result in deep structural knowledge. Scardamalia and Bereiter’s (1999) theory is organised around ill-structured problems to enable deeper connection, which they claim are vital to invention and theorising.
4. *Discourse as collaborative problem-solving*, with a constructive and progressive quality with the aim of enhancing knowledge and improving ideas. Its emphasis is to generate progress towards the solution of shared problems of understanding, rather than merely reaching an agreement, and involves a set of commitments to: (a) progress, (b) seek common understanding and, (c) expand the base of accepted facts.
5. *Constructive use of authoritative information* which invites students to question information rather than meekly accept authoritative pronouncements, because the teacher says so, or the book says so.
6. *Understanding as an emergent goal* is at the heart of the theory and is paradoxical. The rationale of the emergence approach is to be responsive to potential expansions of the range of what is possible.

According to Scardmalia and Bereiter (2005), knowledge-building promotes innovation in learning and builds on connectionist and complexity models:

Connectionist models of learning and development characteristically generate progress from a conceptually impoverished to a conceptually richer system, sometimes by a process analogous to learning from experience and sometimes only by internal self-organization. Connectionist models are examples of the larger class of dynamic systems models, all of which attempt to deal in some rigorous way with emergent phenomena. The emergence of complexity from the interaction of simpler elements is found at all levels from the physico-chemical to the sociocultural. (Scardamalia & Bereiter, 2005, p. 111)

Connectivism is based on the idea that knowledge and learning are distributed across a social, conceptual network, learning is focused on connecting specialised information, and sets up specialised nodes in a common network for common goals. This use of knowledge in new, emergent, complex real-life situations contrasts with traditional schools of thought that promote a learning progression that starts with hypothesis testing and control of variables (Kuhn et al., 1992, in Scardamalia et al., 2012).

Osborne and Dillon (2010) stress that the process of developing new knowledge begins with observations of the world and asking causal questions. They explain that the nature of science and the role of science teachers should consider three interrelated issues that are common all over the world: first, the science curriculum has changed and continues to change in the light of developments in science and technology in the wider world. Second, the roles and responsibilities of science teachers have changed as the value of science to society has developed and broadened. Third, the training available to science teachers has evolved because of major changes in education often instigated for predominantly political purposes (Osborne & Dillon, 2010, p. 6).

In addition, although the purpose is not to theorise scientific literacy and knowledge, it is worth mentioning the work of Shulman (1987) around teachers' subject and pedagogical knowledge which suggests an understanding that both content and process are needed for teaching professionals. According to Shulman, the link between knowledge and pedagogy represents a recent tradition, while a century ago the defining characteristic of pedagogical accomplishment was knowledge of content (Shulman, 1987). This is important in knowledge-building because a teaching tradition that relies on content, according to Shulman, represents a blind spot with respect to how content is characterised by teachers (Shulman, 1987) within knowledge-building and traditional schools of thoughts.

3.7.1 Traditional Schools of Thought versus Knowledge-Building

According to Osborne and Dillon (2010), traditional schools of thought could be associated with one of the pervasive myths of our time, which is that there is such a thing as a scientific method. They attribute this misconception to the assumption that scientists share a common approach to logically deducing the knowledge that they derive about the world. In its simplest form, this view sees science as a process of making predictions about the world. These predictions are then tested using an experimental method which requires the salient variables to be identified. Then all variables bar one (the independent variable) are kept constant and the experimenter measures the effect on the outcome or dependent variable – an idea which is consistently reinforced by the emphasis on fair testing (Osborne & Dillon, 2010, p. 8). The experiment is considered successful if the measured outcome confirms the prediction. According to Osborne and Dillon, such views may have origins in logical positivism, which saw the ideas of science as being logically deducible from an observational standpoint.

On the other hand, Scardamalia and Bereiter (2005) argue that results from traditional approaches have not been encouraging in terms of scientific literacy and ascertain that knowledge- and theory-building is possible at early ages (Scardamalia & Bereiter, 2005). They carried out experiments with students as young as 6 or 9 and compared learning with similar

students who had followed more traditional inquiry approaches where traditional hypothesis and testing were the norm. They showed that in knowledge-building classes, there was no explicit teaching of scientific method, and no carrying out of pre-specified experiments. Yet, “when free to pursue problems of understanding on their own initiative, students were observed to engage spontaneously in a good deal of theorising” and were supported in creating, exploring, and considering theories from multiple perspectives (Scardamalia & Bereiter, 2012, p.8).

Another experiment with young students engages learners in theory-building to determine whether isopods desire moist or dry soil. Rather than test a hypothesis using specific methods, as is usually the norm in science classrooms, students were given a terrarium and asked to work in groups to keep the organism alive. To do so, they had to select what questions to ask, how to run the research, when to use technology, and so forth, which is different from interventions that require teachers to rely on automated, effortless problem-solving (Riel & Becker, 2008).

Scardamalia & Bereiter’s (2005) extensive research around knowledge-building with ICT reveals that collaboratively, teachers are able to engage learners in developing conceptual understanding which requires teachers’ epistemic and agentic action in iterative processes to transform their own mind frames as they learn to conceptualise new ways of selecting questions to ask, of conducting research, and of using ICT (Scardamalia & Bereiter, 2005). Scardamalia & Bereiter stress that the improvement of ideas is nurtured through collegial – not prescribed – unstructured communication, that is free flowing and casual (Scardamalia & Bereiter, 2005). They refer to dialogue as discourse and the social composition of conversations to advance reflective ideas and knowledge-building.

The combination of knowledge-building with ICT could be associated with STEM, (science, technology, engineering, and mathematics) learning. Central to STEM is the engagement of learners in science and/or mathematics in ways that are “authentic, interesting and meaningful to the learners themselves” (Howes et al., 2013, p.1). The essentials of STEM

education are, (1) being able to think scientifically and mathematically, (2) being a scientifically informed individual, (3) engaging in practical work and problem-solving, (4) understanding the developments in science and technology through collaboration and dynamic dialogue, (5) making use of the convergences of technologies, (6) engaging learners in cross-disciplinary skills, and (7) reflecting the nature of scientific inquiry and technological innovation across the world (Royal Society, 2014).

Such an explanation recognises the complexity and interrelation of technology, scientific, and mathematical thinking and learning in the wider sociocultural ecological environment of technology and society. Research around STEM in the physics classroom reveals the importance of relating the interests and life experiences of students to different scientific concepts, including those with high levels of depth which resulted in students developing a conceptual understanding of scientific concepts (Huang et al., 2015). However, STEM learning tends to be associated with inquiry learning which shares a similarity with knowledge-building, yet is different in how learners engage with theoretical and conceptual learning (Scardamalia & Bereiter, 1999). Avramedis et al.'s (2014) implementation of STEM TPD with 57 teachers provided with learning designs is of interest because it shows that engaging teachers in top-down inquiry questions does little to recognise the importance of teacher agency and advancing knowledge-building ideas as described by Scardamalia & Bereiter (Scardamalia & Bereiter, 1999).

Hence, how does the knowledge-building pedagogy concord with pedagogies associated with the ICT proposed in the intervention? As will be explained in the Section 3.8 and in Chapter 4, the intervention utilises ICTs that may lend themselves to physical computing similarly to maker-spaces, and thus examining the affordances and pedagogies associated with maker-spaces is helpful.

3.8 The Concept of ICT Affordances

The intervention provides ICT that enables the creation of physical artefacts with motors

and sensors and Raspberry Pis (RPis)³, and/or digital artefacts such as stories, interactive media, pictures, presentations, or texts. Thus, explaining their affordances to teachers is important to avoid misconceptions and technological determinism (Oliver, 2011), which in its simplest form assumes that “technology is a force of social change and determines agency” (Selwyn, 2011, p. 66; Oliver, 2011). Technological deterministic thinking is associated with a tradition of “political and academic discussions about the effect of technology on education” (Selwyn, 2011, p. 34). It can be exemplified in Cuban’s (2002) research which illustrates a sharp contrast between determinist assumptions represented in educational policies and teachers as actors and agents (Selwyn, 2011; Cuban, 2002). Cuban’s (2002) research is referenced in Appendix G.

Indeed, a growing body of work (Oliver, 2011; Pachler & Noss, 1999; Selwyn, 2011; Cuban, 2002; Laurillard, 2008) has warned that the danger of this way of thinking about technology in education is that we end up with simplistic cause-and-effect assumptions. Yet, two decades later, political debates and discussions surrounding ICT affordances in maker-spaces seem to contemplate maker-space technologies deterministically as “autonomous forces” (Nye 2007, p. 27) to transform society and education (Weiner et al., 2020), undermining teacher agency (Nye, 2007; Weiner et al., 2020). This could be associated with the motivation observed in a “community of hobbyists, tinkerers, engineers, hackers, and artists who creatively design and build projects for both playful and useful ends” which is discussed in Section 3.8.1 (Martin, 2015, p. 30).

3.8.1 Knowledge-Building, ICT, and the Maker Movement

The literature around ICTs used in maker-spaces in schools is scarce and associates the movement with Papert (1991) and Piagetian constructivist pedagogy (Piaget, 1970), connectivism, and STEM learning (Schad & Jones, 2020; Halverson & Sheridan, 2014; Martin,

³ The Raspberry Pi is a low cost, credit-card sized computer that plugs into a computer monitor or TV, and uses a standard keyboard and mouse.

2015, Bevan et al., 2014). Generally, the movement describes teachers and learners' motivation to tinker, learn by trial and error, and engage freely in making with ICT out of school (Halverson & Sheridan, 2014; Martin, 2015).

The movement seems associated with design thinking which is another school of thought happening outside schools. According to Nesta's review (Luckin et al., 2012), design thinking within maker-spaces includes ideating and creating solutions around making with digital tools with a general "resurgence in craft and making and growing opportunities for people to integrate physical construction with coding" (Luckin et al., 2012, p. 25). According to Jarrett (2016), design thinking is a process that helps people discover and implement solutions to problems. It is a way of problem-solving that relies on individual creativity, effective teamwork, and a willingness to fail and try again, repeatedly, until the optimal solution is identified (Jarrett, 2016). Similarly, Bowler (2014) explains that "thinking like designers gives students ownership over their projects and as a result, enhances their creative confidence, involves trial and error, multiple design/test stages, figuring out workarounds, "good enough" solutions, and ongoing cost/benefit analysis" (Bowler, 2014, p. 60). Scardamalia & Bereiter (2017) suggest that knowledge-building and design thinking may be complementary yet require that individuals shift their modes of thinking between them (Scardamalia & Bereiter, 2017). However, little to no research around maker-spaces in schools seems to combine knowledge-building with design thinking.

In Nesta's review, Luckin et al. (2012) looked at making with a lens of learning, stating that "making and sharing things is one of the best ways people can learn" (Luckin et al., 2012, p.25). Sheridan et al. (2014) suggest that making should include "creative production in art, science, and engineering" where people of all ages blend digital and physical technologies to explore ideas, learn technical skills, and create new products (Sheridan et al., 2014, p.496). Such motivation to build and create does not seem to be associated with knowledge-building and innovation in learning in the way explained by Scardamalia and Bereiter (2005) or

happening in schools when teachers of sciences, for example, followed instructions to teach students how to create projects for their school maker fair (O'Brien et al., 2016). As emphasised by Luckin et al. (2012) in Nesta's review, even though making and coding are taken up in non-formal spaces, "making as learning" remains an immature area (Luckin et al., 2012) with a lack of methodological clarity in maker-centred learning (Schad and Jones, 2020; Luckin et al., 2012).

On the other hand, Weiner et al. (2020) caution such deterministic views of ICT while Vossoughi & Bevan, (2014) critique culturally narrow and normative definitions of making focused on technological forms of innovation. They argue that these technological forms advance hands-on learning and contribute to the growth of the economy driven by values of productivity (Vossoughi et al., 2016, p. 208; Weiner et al., 2020; Vossoughi et al., 2014). They critique the movement as one about creating artefacts, consumerism and productivity, which dehumanises the person making with the creation of products, and undermines the learner and learning (Weiner et al., 2020; Vossoughi et al., 2014, 2016).

Such a critique is a reminder of the dichotomy between the use of ICT as a tool versus as a mediator of learning, with an understanding that it is not about devices but the centrality of the person using it (Turvey & Pachler, 2016). Thus, central in the process of learning are teachers who arguably ought to learn how to design learning (Laurillard, 2008) to help elicit learning, rather than use ICT superficially, whether to make and construct physical things or to create and share pictures and text. Arguably, this requires a change of pedagogy regarding the use of ICT.

Interestingly, the literature around maker-spaces speaks of open culture, motivation, and engagement with ICT; yet it does not theorise maker-space technologies nor address how teachers and learners relate to such ICT. Selwyn (2011), for example, discusses the shortcomings of ICT and socially deterministic views and stresses social and pedagogical theory while Sharples et al. (2006) suggests that ICT should support learners to reach personal

understanding through conversations, explorations, and collaborative learning in order to construct common knowledge and support them in transitions across learning contexts (Selwyn, 2011; Sharples et al., 2006). This gap around researching ICT used in maker-spaces leaves space for further studies to theorise and unveil their relationship with agency in practice.

3.8.2 Pedagogical Goals and ICT

Selwyn (2011) and Webb and Cox (2004) emphasise that learning with and about ICT requires an adaptation of pedagogical reasoning and practices. Webb and Cox (2004, p. 278), Selwyn (2011), and Brown et al., (1989) suggest that learning about tools has no meaning without the activity, context, and culture in which they are taught. Indeed, the work of Scardamalia and Bereiter (2005, 2016, 2017), Scardamalia et al., (2012), similarly to Riel and Becker (2009) and Somekh (2008) does not seem to isolate pedagogical transformation from learning how to use ICT. In particular, Somekh (2008) stresses three situated and transformative interventions as researched by Sandholtz and Ringstaff (1996), Krumsvik (2006), and Hinojosa et al. (2002). The three studies are referenced in Appendix H.

The emphasis in those three studies is on changing the pedagogical process of learning and enabling teachers to acquire high-level ICT skills as a spin-off from using them purposefully to find things out and create products (Somekh, 2008). Such a way of using ICT reinforces *in situ* learning observed in the literature using web-based platforms. For example, Scardamalia & Bereiter (2016) connect knowledge-building with ICT-based platforms to support advancing knowledge-building on ideas and theories, and emphasise the need to constantly shift between knowledge-building mode and design mode (Scardamalia & Bereiter, 2016, 2017). Similarly, Laurillard (2008) refers to ICT to support teachers' thinking processes to design learning and plan tasks, using ICT in listening, reading, discussing, practising, experimenting, exploring, adapting, reflecting, producing, and articulating learning (Laurillard, 2008).

Furthermore, Somekh (2008) draws out common features that distinguish transformative pedagogy with ICT and stresses the purposeful use of ICT and the interlinked changes in

established epistemologies of the school through the mediating effect of ICT and changing pedagogies. Arguably, transforming pedagogical goals can be intertwined in the intervention with learning to use ICT, enabling teachers to learn about them as they learn new approaches, and teachers would then need to understand their affordances. However, those pedagogies and approaches are part of teachers' cultural practices and belief systems and are discussed next.

3.8.3 Teachers' Beliefs

Bruner (1999, p. 5) asserts that teachers' capacity to make decisions and choices is driven by their beliefs and assumptions about learning and is "a direct reflection of teachers' own prevailing philosophy of education". This is echoed by academics Biesta & Tedder (2007), Loveless et al. (2006), and Cox et al. (2004) with an understanding that teachers' agency is shaped by both beliefs and judgements about what is possible given existing resources and constraints (Biesta & Tedder, 2007; Loveless, 2011; Cox et al., 2004). Webb and Cox (2004) analysed teachers' perceptions of ICT in practice, with the premise of pedagogy as guiding principles about ICT, and pedagogically focused approaches in TPD. They suggest that teachers' agency in practice depends on the relationship between ICT and pedagogy and that teachers need a certain degree of confidence in order to engage in the process.

Richardson (2003) explains the centrality and stability of beliefs when those are positioned within anchored belief systems, particularly when pedagogical beliefs are embedded in cumulative experience formed over many years (Richardson, 2003). Beliefs around tackling knowledge-building with ICT through ill-defined problems in the manner described in the intervention are thus complex, since they do not fall into the repertoire of what teachers experienced or learnt, as compared to routine processes anchored in school systems and structures which place them in contradicting situations (Giddens, 1991). The changes in beliefs observed in pragmatic experience encouraged the undertaking of this intervention and teachers' previous and current experiences are referenced in Appendix I.

As explained by Somekh (2008), there is a duality in learning about pedagogy and learning how to use ICT in a way where one influences the other. Across the literature, research in classroom decision-making involving hands-on use of ICT projects suggests that knowledge-building and open-ended activities are challenging for teachers, causing levels of anxiety or stress (Loveless et al., 2006, p.10; O'Brien et al., 2016; Martinez & Stager, 2014; Bevan, et al., 2014).

Similarly, science teachers in Lebanon (Saad & Boujaoude, 2012) and internationally (Kurup, 2014) generally ascribe to a realistic view of science; that is, that scientists are engaged in discovering laws and theories that already exist and are proven (Saad & Boujaoude, 2012; Kurup, 2014). Scardamalia and Bereiter (2016) explain that teachers find it challenging to adopt emergent approaches partly because they tend to “believe that knowledge resides in people’s minds” (Scardamalia & Bereiter, 2016, p.16) and partly because they believe that knowledge-building is cumulative and sequential such as in *Bloom’s Taxonomy* (Scardamalia & Bereiter, 2016; Bloom’s Taxonomy, n.d.). This is echoed by O’Brien et al.’s (2016) work with science teachers who were tasked with preparing their students to make their fair projects and their reliance on modelling science experiments to validate theoretical knowledge (O’Brien et al., 2016).

3.9 Constraints to Teacher Agency

The intervention, as described in chapter 4, does not aim to merely have teachers react but to actively design and implement projects with students. Yet, for teachers to do this, academics seem to agree that teachers should have autonomy, freedom, and choice which contradicts the inherent educational structure and systems (Shedd & Bacharach 1991; Hargreaves & Fullan, 2012; Biesta et al., 2015, 2017; Kennedy, 2014).

Foucault (in Gordon 1980) explains how schools constrain agency by producing and reproducing forms of knowledge and power at the micro level through curriculum, scheduling, rigid timetables, and accountability, and compel teachers into being authoritative figures and

students as being subordinates (Foucault, in Gordon 1980; Shedd & Bacharach, 1991). These are recurrent issues in the studies examined and continue to constrain teacher agency (O'Brien et al., 2016; Martinez & Stager, 2014; Martin, 2015; Blikstein, et al., 2017; Blikstein and Valente, 2019; Bevan, et al., 2014).

Gordon (1980) explains that according to Foucault, power constraints operate almost at an unconscious level – so teachers are not aware of it – and in doing so, it normalises individuals to be capable of being governed. Similarly, this is reflected in teachers who become acted upon rather than being actors in hierarchical structures, thus isolating teachers in the classroom (Shedd & Bacharach, 1991, Hargreaves & Fullan, 2012).

In contrast, relationships around ICT and maker-space out of school seem to generate motivation, openness, collaboration, co-construction, and excitement which does not seem to appear when such ICT is used in schools (Halverson & Sheridan, 2014; Martin, 2015; Bevan et al., 2014). Fullan (2001) and Hargreaves and Fullan (2012) emphasise the importance of building relationships around learning as an indicator in favour of school transformation, cultural and pedagogical change (Fullan, 2001; Hargreaves & Fullan, 2012). Those relationships are encouraged and supported in the intervention as outlined in Table I1 in Appendix I and in Table J1 in Appendix J.

As reported by Martinez and Stager (2014), Martin (2015), Blikstein, et al., (2017), Blikstein and Valente (2019), Bevan, et al., (2014), and O'Brien et al., 2016), research around learning in maker-spaces emphasises school constraints of accountability, curriculum, and testing which are barriers to encouraging intellectual risk-taking, building on ideas in the way proposed by Scardamalia et al., (2012), Scardamalia and Bereiter (2005, 2016, 2017) in which learning from one's failure can support the process of learning (Martinez & Stager, 2014; Martin, 2015; Blikstein, et al., 2017; Blikstein and Valente, 2019; Bevan, et al., 2014; O'Brien et al., 2016; Scardamalia & Bereiter, 2005, 2016, 2017; Scardamalia et al., 2012).

Foucault insists that technology does not change the power relation; rather, it changes its form (Deacon & Parker, 1995). This is echoed by Resnick and Rosenbaum (2013) who relate such tensions to earlier ICT-driven and inquiry-orientated pedagogies, side-lined by the last two decades of accountability era schooling (Resnick & Rosenbaum, 2013). Indeed, tensions emerged around content-focused instruction (O'Brien et al., 2016), accountability, test-centric education, and discourses of failure critiqued as replicating unfavourable views of students (O'Brien et al., 2016; Blikstein, et al., 2017; Bevan, et al, 2014).

3.10 Gaps in the Literature

The scant research surrounding teachers of refugees has encouraged a deeper analysis of more general ICT, maker-space, and teacher professional development literature. In addition, there are very few studies that address teacher agency using ICT in practice in challenging contexts and there is a scant amount of literature which supports, outlines, or relates to the integration of ICT into teachers' practice using maker technologies (Schad & Jones 2020, p. 75). Furthermore, research around teaching refugees in schools is mostly conducted in high-income countries yet 86% of refugees are learning and living in low-income countries where there is a lack of teacher capacity, rigid structures, and systems, which adds layers of complexity that are often political in nature. Thus, research around refugee learning in schools in challenging contexts does not seem commensurate with the scale of the refugee phenomena and the lack of teacher capacity around the world.

Much of the work has focused on putting forward the problem and acknowledging refugees' rights to education, with a tendency to revert to deterministic thinking around ICT solutions (Weiner et al., 2020; Dahya, 2016; Unwin et al., 2017). The evolving and growing nature of the refugee problem shows a significant gap around frameworks to conceptualise interventions that can strengthen teaching and school learning in challenging contexts. Teachers play a crucial role in the life of refugees, yet their professional development remains undertheorised and undermined by deterministic thinking or stymied by the overbearing nature

of inherent problems (Kennedy, 2014). Generally, in the field of education and more particularly in challenging or shifting contexts, teacher agency in practice has been underexamined and subject to little explicit research and theory development (Kennedy, 2014; Biesta et al., 2015, 2017; Chaaban et al., 2021; Jones & Charteris, 2017; Imants & Van der Wal, 2020) which further supports this research.

3.11 The Conceptual Framework

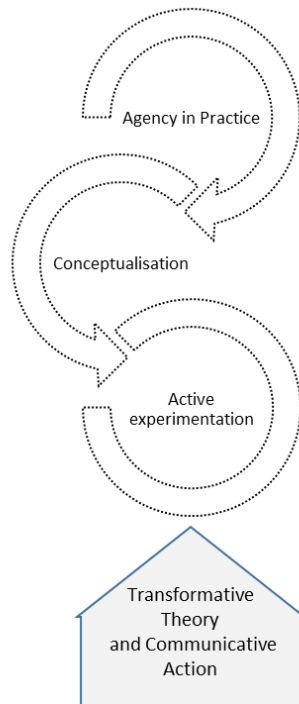
The intervention is anchored around nurturing agency in a context that is inherently constrained and determined by systems and cultural practices that perpetuate knowledge transmission, and reductionist approaches that undermine teacher agency. The intervention is a practical model – i.e. not only aspirational – that strengthens knowledge-building processes and brings agency to life in practice through a shared experimental experience of what teachers are learning in an iterative process.

The pillars that underpin the concept of agency are rooted in German philosophy, with the concept of “lifeworld” which originates from the “world of lived experience inhabited by us as conscious beings, and incorporating the way in which phenomena, events, objects and emotions appear to us in our conscious experience or everyday life” (Brooks, 2015 p, 642). The intervention emphasises teachers’ agency as an act of appropriation as teachers conceptualise and design a project of their own which stems from their lifeworld through communicative action (Habermas, 1985) and transformative learning (Mezirow, 1991)

Appropriation provides learners the opportunity to negotiate learning and express their understanding “using a range of sign systems such as language or images” (Pachler et al., 2010, p. 4) or constructing physical artefacts. Complexity thinking and postmodernity remain overarching umbrellas that help to make sense of the contradictions and dilemmas that teachers face in exerting agency in practice. It allows the recognition of the intricate, interlinked, and unpredictable nature of learning and the challenging of instrumental or deterministic views of learning with ICT (Turvey & Pachler, 2016).

While all these concepts have been theorised to different extents, they are brought together in a specific manner as now explained. According to Mezirow (1991), agency happens when individuals become critically aware of their changing beliefs and mind frames, and begins with a person being engaged in experiential activities that cause a shift of their frames of reference. The shift may be fast or slow, incremental or iterative, and may be brought about through different domains such as communicative action (Habermas, 1985) and reflective thinking (Howie & Bagnall, 2013). Experience with teachers reveals that part of the challenge that teachers face is the distance they have from situated learning, their reliance on routine processes, and what Scardamalia and Bereiter (2005) refer to as reductionist views of the problem, inquiry, or projects in learning.

What the intervention does is to ask teachers to step away from their routine processes by putting them in a world context; raise questions based on observation and practice in a situated intervention that builds on the notion of teachers' lifeworld; allow them to experience and express intersubjectivity and inter–intra relationships in collaborative learning; and make connections with their learning objectives before conceptualising projects. Experience with teachers has shown that this is possible and draws on Laurillard's (2002) conversational theoretical framework, combining teachers' experience and theoretical perspectives, and empowering teachers to have their own account of what it takes to design learning. The focus then becomes about changing the pedagogical process and using ICT purposefully to find things out and create products.

Figure 6*Agency in Action Conceptual Framework*

Mezirow explains that one way that transformation occurs is through a disorienting dilemma such as “aha” moments, leading to a modification of thinking which drives action (*Mezirow*, 2000). This seems to be in accordance with *Emirbayer* and *Mische* (1998), *Biesta* and *Tedder* (2007), *Biesta et al.* (2015), notion of agency as an emergent phenomenon of actor-situation transaction that has its origin in experiential learning, and is a function of sociocultural dimensions beyond the constraints of structure and triggered by problematic or challenging situations (*Emirbayer & Mische* 1998; *Biesta & Tedder*, 2007; *Biesta et al.*, 2015).

Transformative theory according to *Mezirow* (2000) may be defined as learning that transforms problematic frames of reference to make them more inclusive, discriminating, reflective, open, and emotionally able to change. *Mezirow* described transformation as the process of becoming aware of how and why our assumptions have come to constrain the way

we perceive, understand, and feel about our world; changing these structures of habitual expectation to make possible a more inclusive, discriminating, and integrative perspective; and, finally, making choices or otherwise acting upon new understanding (Mezirow, 1991, p.167 in Morley et al., 2020, p. 520). Mezirow's (2000) transformative theory builds on Habermas's (1985) work and suggests that critical reflections on underlying assumptions is not a solitary activity but takes place through discourse or dialogue with others which is brought about in the intervention, drawing on Laurillard's (2002) conversational framework. Mezirow was concerned with dialogue devoted to assessing contested beliefs, arguing that it is through such discourse that the process of transformation is developed and enacted (Mezirow, 2000).

Experience with teachers in TPD using collaborative dialogue around learning, and the dilemmas teachers face as they attempt to adapt and appropriate such learning within school structures, reveals the potential of dialogue to support teachers to reflect on their practice and experience as a shared rather than an individual activity. Mezirow (2000) argues that changing sociocultural beliefs involves a particular component of dialogic discursive communication through experience after action and maintains that the development of such skills, which is essential in promoting awareness, fosters agency and transformation of mind frames. Thus, the process of acting to appropriate learning at the individual and group level seems nested in a set of relationships that may drive agency in practice which is arguably worth examining. Previous experience with teachers has shown that these moments are possible when teachers have the opportunity to step out of their routines, invest themselves as individuals immersed in intersubjective learning, and question their lifeworlds.

Habermas's (1985) Communicative Action and Lifeworld concept originates from German philosophy and builds on Heidegger (1859–1976) and Husserl (1859–1938). “Phenomenology provides a philosophical rationale for focusing on the study of human experience which Heidegger associated with the development of existential or hermeneutic phenomenology based on the belief that human beings are inseparable from the world in which

they live” (Smith & Rhodes 2015, p.197). Husserl was concerned with developing phenomenology as a rigorous alternative to methods traditionally used by the natural sciences, which Husserl believed was inappropriate for the examination of human experience (Brooks, 2015). In contrast to notions of an objective reality, Husserl suggests that it is in fact only our experience of the world – direct and subjective human experience – that is knowable (Husserl, 1983). We can, Husserl argues, only really know and understand concepts when they are grounded in concrete experience (Husserl, 1983). Habermas (1985), on the other hand, stresses the concept of shared experience of a group and seeing things from the point of view of the group of actors around shared cultural and linguistic resources.

This concept is central in the intervention, and bridges a hermeneutic approach to phenomenology with communicative action. Habermas (1985) associates the Communicative Action and Lifeworld concept in reference to three worlds: (a) the objective world, about which statements can be true or false; (b) the social world, in which things can be (by common consent) right or wrong; and (c) the subjective world, the world of the speaker’s own psyche, about which the speaker can report sincerely or otherwise (Habermas 1985, pp. 98–101). Based on experience, it has enabled teachers to relate to rather than distance themselves from learning and to transform their mind frames, connecting socioemotional and cognitive skills in relationships and connections that they could not make before.

Awareness as theorised by Mezirow (2000) is nurtured in the intervention through communicative action (Habermas, 1985) centred around the core concept of lifeworld in knowledge-building between teachers in a shared experience (Habermas, 1985; Mezirow, 2000). It is in congruence with Vygotsky’s developmental theory which emphasises the unity of behaviour and consciousness of one’s thoughts and beliefs. This unifies the mind with social interaction as a major characteristic and defines what constitutes learning with and from others.

Vygostkian theory (1978) suggests that collaboration around real-world problems or tasks that build on each “person’s language, skills, and experience shaped by each individual’s

culture” (Vygotsky, 1978, p. 102) is an approach to learning that enables learners together to construct their knowledge, conduct research, pose questions, produce and co-produce knowledge (Vygotsky, 1978, p. 102). This is echoed in Scardamalia and Bereiter’s (2005) sociocultural knowledge-building pedagogy with the belief that all learning results from social interaction and that meaning is socially constructed through communication, activity, and interactions with others.

The second construct that is rooted in German philosophy (which influenced Vygotsky’s philosophical work and is a radically different idea of rationality and epistemology from that characterised as an abstract and objective conceptualisation) is the concept of “Lebenswelt”, the German word for the world in which we live and exist, and from which we cannot separate rules, procedures, and the development of skills and capacities. Thus, there is a unifying concept associated with abstraction and generalisation, with an emphasis on multiple ways of making meaning which is sustained by variations in cultural experiences and forms of life as a social formation. It is a space where the human mind can no longer be detached from the conditions within which it develops.

Vygotsky maintains that every function in cultural development appears twice: first, on the social level and later, on the individual level; first, between people (inter-psychological) and then within at the intra-psychological level (Vygotsky, 1978). This applies equally to voluntary attention, to logical memory, and to the formation of concepts. All higher functions thus originate as actual relationships between individuals (Vygotsky, 1978, p. 57). This suggests that relationships are vital at the individual and collaborative levels as teachers engage in communicative action around their lifeworld – objective, social, and subjective. Of essence is the immersive nature of the experience which brings around the notion of self in the world and nurtures intra–interrelationships, awareness, and thus agency. The intervention thus favours those relationships as a shared learning experience and enables teachers to connect their

individual inter-subjective world with inter-intra group relationships. A list of relationships is in Appendix J.

In addition, the use of ICT is an important element which is conceived as affordances that mediate learning rather than only as a tool, as theorised by Pachler et al. (2010) with the centrality of the “self” as a learner. This implies a relationship between the individual and ICT which is explained by Sharples et al. (2006) as a continuum diffused amongst interactions and reciprocally constructed – not as a fixed shell surrounding the learner, but as a construct that is shaped by a continuously negotiated dialogue between people and technology. This notion of interaction with ICT seems important, yet we know little about how everyday life routines and technological structures (including ones that enable physical computing) influence how learners engage in this dual relationship. All those relationships around learning with ICT, in addition to inter–intra relationships, are intricate and interdependent and seem to converge to agency in practice.

Although agency has been thoroughly examined in social theory, little is known about agency in practice, particularly in challenging contexts. Thus, the intervention will shed light on agency in practice and raise new questions surrounding the intricate, interdependent relationships around learning, the situated TPD aspect, and ICT in challenging contexts, albeit unveiling what is possible, given existing resources, constraints, and beliefs which arguably contribute meaningfully to knowledge.

3.12 The Analytical Framework

The analytical framework draws on a combination of strategies used to make sense of the data, memos, notes, and transcripts collected during the fieldwork, while highlighting the dynamic relationship of the three main elements of the sociocultural framework and focusing on what drives or constrains teachers’ agency.

The collection of data was done through interviews and observation of the intervention. Having started from the field, an initial narrative description of the phenomena was produced

before returning to the conceptual theoretical framework and literature. The data were tabulated into an Excel spreadsheet and scrutinised several times before being organised into themes and sub-themes and compared with those data that appeared in the literature. The initial description of the event and transcripts was extremely rich, and part of the difficulty was focusing on one element within the initial research question (in terms of what learning is fostered when Lebanese teachers engage in a technology-enhanced learning (TEL) intervention with refugee children). The focus on the notion of teacher agency surfaced after conducting the fieldwork and reviewing the literature, which enabled the weaving of the teacher agency concept across the theoretical framework and conceptual framework. Thus, agency is central yet overarching with the other two elements – the structure of the TPD and teachers' cultural practices – and is discussed in accordance with its “iterational, present and projective dimensions” (Biesta et al., 2015, p. 3).

The process was cyclical and iterative within two repeated cycles of the intervention conducted in the same way and the data were handled reflexively and interpreted with the group of teachers before stating findings and drawing conclusions. The analysis also included rival explanations (Yin, 2018), of one teacher who provided alternative descriptions and interpretations than the others. Being aware of this early in the intervention, attempts were made to understand the “potency of the other influences rather than finding a reason to reject them” (Yin, 2018).

In conclusion, the sociocultural framework provided the overarching categories for the themes and sub-themes as Teacher Professional Development, Cultural Practices, and Agency – and the initial data and themes drawn from the first cycle of analysis were fitted into the categories with examples of what the teachers said. The categories included are the following:

- *The TPD as a structure*, teachers' present experience in it, and the constraints they mitigated in the education system;
- *Teachers' cultural practices*, how they relate to their past “habitus”, the routines they

engage in in their everyday lives, their beliefs about ICT, the pedagogy proposed, and their subject specialism;

- *Agency*, as their ability to take action, to use what they learnt, to appropriate it, to design and implement projects, and the artefact created.

Chapter 4 provides a detailed account of the intervention.

4 The Intervention

Chapter 4 explains the genesis of the intervention and its relevance in a refugee context. It provides an overview of its six phases, specific features, technological and pedagogical kits, and a detailed description of the implementation.

4.1 Genesis of the Intervention

The International Education Association (IEA) started working with teachers of refugees at the onset of the Syrian education crisis (2013). Through a partnership with UNICEF Lebanon, IEA designed a non-formal, thematic, six-week, technology-enhanced, knowledge-building curriculum, using the Raspberry Pi (Raspberry Pi, n.d.) around basic literacy, numeracy, and health with training and coaching. As a result of the programme, children's learning was accelerated and teachers reported that they were able to achieve in six weeks what they had previously not been able to do in six months (Hawker, 2015).

In addition, educators with little-to-no educational background adopted the process and applied the skills gained past the project end. Beyond impacting teachers, the intervention implemented with teachers of refugees impacted the learning environment with more social cohesion amongst the student population, less violence, and more motivation and engagement of the children (Tawil, 2018). Those wider impacts on the learning environment, and the fact that educators sustained the methodology past the six weeks, encouraged IEA to consider how to apply a technology-enhanced, knowledge-building intervention with school teachers to enhance mainstream learning and to reach a larger number of refugees and vulnerable Lebanese learners.

Before starting, IEA conducted a reflexive study and reviewed frameworks for refugee education, UNESCO's ICT Competency Standards for Teachers, the maker movement, and the UK School Curriculum (UK Government, n.d.) and Wales international competence frameworks (Welsh Government, n.d.) for digital skills and literature around ICT integration in teacher education. In addition, IEA consulted Lebanese middle and secondary school science and technology teachers to discuss the challenges faced in teaching refugees and what concepts were particularly challenging to explain.

The main gap identified was the lack of a framework that could sit alongside the existing school system to strengthen learning and promote innovative pedagogies with ICT, without being bound by the school system's rigid structure. Additional gaps included deterministic views attributed to ICT, reductionist understandings of learning, fragmented solutions, and the lack of skills for the future. On the other hand, refugee education and integration frameworks emphasised the core domains of education for refugees around "success, safety and belonging" (Kohli, 2011, p. 314), human rights with recognition, redistribution, representation (Fraser, 2003), and social integration (Ager & Strang, 2008). While each framework is important in itself, it is not clear how they could be put into practice, particularly in mainstream schooling.

In parallel, the emergence of low-cost ICT such as the Rpi seemed an opportunity to address a long-standing problem of access to ICT in schools in disadvantaged parts of the world. Indeed, as explained by Unwin et al. (2017), access to ICT remains the biggest hurdle to learning in challenging contexts. Thus, the affordable RPI and low-cost sensors opened up new possibilities to provide such an access. They come, however, with the affordances of physical computing, such as are seen in maker-spaces (Stanford University, n.d.) emerging outside learning. Such examples are surfacing in challenging contexts such as in UNICEF Innovation Labs (UNICEF, 2014) accompanied by the excitement of the promising potentials of ICT and the emergence of both fabrication and communication technologies. As explained earlier in Chapter 3, ICT tools associated with maker-education seem to associate innovation with the creation of

new products. This adds to the tensions surrounding innovation in education, which is often attributed to technology rather than pedagogy.

As explained by Scardamalia and Bereiter (2005), pedagogic innovation lies in knowledge-building, problem-solving, and preparing young learners with skills for the future. On the other hand, the maker movement is supported by frameworks such as IDEO's design thinking (IDEO, n.d.) for ideating and creating solutions around making with digital tools, with a general "resurgence in craft and making and growing opportunities for people to integrate physical construction with coding" (Luckin et al., 2012 p. 24). The maker movement is explained as "a community of hobbyists, tinkerers, engineers, hackers, and artists who creatively design and build projects for both playful and useful ends" (Martin, 2015, p. 30).

With no framework applied to learning, IEA considered that there was a potential to reach a wider number of teachers and was interested in leveraging the potential of low-cost ICT around emergent problems and knowledge-building (Scardamalia & Bereiter, 2005). Underpinned by extensive and robust research, Scardamalia and Bereiter's (2005) knowledge-building theory provided a solid foundation for the Creative Process, combining knowledge-building with innovation to create solutions to community problems. The understanding of innovation adopted in this research is aligned with researchers such as Scardamalia and Bereiter (2005) who tie knowledge-building, ICT, problem-solving, and skills for the future to innovation.

Hence, the Creative Process was designed by combining learning goals with ICT in school learning while promoting skills for the future. It provides a structured six-phase approach around knowledge-building and innovation in which teachers engage learners in a knowledge-creating culture with peers and in the community. Once teachers experience it, they reflect, make connections with theory, and design a project to implement with students.

The six-phase process requires learners to collaborate, brainstorm, tinker, identify a problem, imagine, sketch, design, construct, and create solutions which they code. Problems

are selected by learners in collaboration with their teachers around community issues. There is a high degree of relatedness with one's surroundings, self, and community. The problem identified results from brainstorming sessions between teachers and students. Teachers work closely with their students, guide them in the process, and make connections with their learning goals. Classroom learning extends after school with project work. Students collaborate and communicate with each other and with members of the community, growing their social capital. The six phases are briefly explained in Section 4.2 with a visual depiction provided in Figure 7.

4.2 The Six-Phase Process

The six phases of the Creative Process are “observe, research, imagine, design, create, review”.

Figure 2

Schematic Table of the Creative Process

Stage	Observe	Research	Imagine	Design	Create	Review
Process Objective	Gain insight into; Self Surrounding Community Natural surrounding Question and explore your community	Identify a problem Formulate the problem Research the concept Justify why it is important	Brainstorm designs: Defer judgment Encourage wild ideas Help students to build on the ideas of others and focus on the topic; propose a design	Make a plan (5W) Design your prototype Share your design Adjust your design	Build your prototype based on your design and the problem / solutions proposed Use things around you	Test, verify that the design meets the original problem objectives; Evaluate the prototype ; Analyze and discuss what works what does not; what to improve
Outcome	Concept Map • Ideas • Community • discussion points	Gain insight into your: Self Community Surrounding Articulate a problem that is worth being addressed	Propose a design to address the question	Design a prototype include in It electronics and materials needed	Create the prototype Start adding the circuitry and the code	Test, review and refine, debug if necessary Reflect on the process Identify and improve what works well/ what does not work well
Technology Objective	Learn and apply: Raspberry Pi essentials Basic circuitry: LEDs, resistors, breadboard Self-exploration	Learn and apply : Electronic: ultrasonic sensors, LED(s), combination of LED and ultrasonic sensors	Learn and apply : - Motors: servo and DC - Integrate multiple electronics together	Learn and apply : - Rpi Camera, - Humidity Temperature sensor Decide what electronics to use in your design	Create: Implement what you've learned: - Build your circuitry - Code	- Create: Test your program - Debug your code - Finalize
Communicate and Share						

4.2.1 Phase 1: Observe

During the observe stage, learners observe and question themselves, their surroundings, and their community. They create a mind map which includes their interests and perceptions of themselves and their community. Mind maps are done using pen and paper, and presented at the end of the session. In parallel, teachers are given a choice of simple open-ended problems that do not require any technology, and invest themselves in topics that they would like to investigate. ICT affordances are discussed and towards the end of this first phase, they start exploring passive basic circuitry before engaging with ICT during the research phase.

Accordingly, it involves teachers not only in developing knowledge-building competencies but also coming to see themselves as agents to advance knowledge frontiers

(Scardamalia & Bereiter, 2005, p. 98). In this context, knowledge-building has a collective purpose, and the activity becomes a realistic means for mapping collaborative thinking and connecting learners in knowledge-building.

4.2.2 Phase 2: Research

The dynamics of knowledge-building as explained by Scardamalia and Bereiter (2005) is based on an understanding of addressing “emergent problems”. This contrasts with the concern of passive education and the concept of knowledge situated in the heads of teachers. This “out-in-the-world character of learning” (Scardamalia & Bereiter, 2005 p. 40) enables learning to emerge from the practice of groups and is the concern of situated cognition and Communities of Practice (Lave & Wenger, 1991). According to Scardamalia and Bereiter (2005), what makes knowledge-building a realistic approach to education is the discovery that children as young as 6 or 9 can engage in it. Thus, the aim of the research phase is to enable teachers to conceptualise those linkages with learning goals as they guide learners in expressing their interests, what community means to them, and to investigate this more deeply as they decide on problems to address.

The dynamic is social on two levels, in the intervention with teachers learning together (Lave & Wenger, 1991) and between teachers and learners when they return to school (Scardamalia & Bereiter, 2005). Teachers learn, through simulations of open-ended problems, how to connect investigative questions to teaching concepts and learning objectives. During this phase, they continue to engage in researching their topic to articulate a specific inquiry question to design their project. They continue to learn and be exposed to technology depending on their subject levels and interests.

4.2.3 Phase 3: Imagine

Once learners have articulated the question that they plan to investigate, they invest themselves in understanding it further and start to explore solutions. They brainstorm, unpack the question, continue to research, make a list of what is known and what needs to be known,

look for what already exists, imagine new possibilities, sketch potential solutions, consider the added value of technology, consider who the solution is for, their goals, requirements, and constraints.

4.2.4 Phase 4: Design

Once they have selected a solution to focus on, the design phase starts and learners elaborate on their sketch, and make an action plan, which includes what they are learning, the materials that they need, who is going to help them at school or beyond, and who does what, when, and where. They share action plans and sketches of their design with facilitators and colleagues to obtain peer feedback.

4.2.5 Phase 5: Create

During this phase, learners start creating or building a prototype which can be physical or totally digital before programming it. A digital prototype can be a Scratch game, digital play, or story, for example, while a physical prototype can be, for example, a device that detects high or low decibels or an automated device that opens in response to an order.

4.2.6 Phase 6: Review

During this phase, corrections and amendments are made with in-depth reflections on learning, failures, and successes. This phase ends with teachers planning next steps and preparing for a sharing event. In turn, the artefacts created become objects for continual testing and improvement.

Communication and sharing are weaved throughout the process. Particular attention is given to designing a TPD process that does not fetishise ICT or have reductionist views of knowledge-construction. As explained by Scardamalia and Bereiter (2003) “when used in education, knowledge-building often serves merely as a glorified label for a broad range of constructivist activities, including collaborative learning, guided discovery, project-based learning, communities of practice, anchored instruction, and so forth” (Scardamalia & Bereiter, 2003 p. 1371). Thus, Scardamalia and Bereiter’s theory provides a foundation focused on

pedagogy around problem-solving with ICT, to make learning a meaning-making experience and prepare young learners, particularly vulnerable people and refugees, to be successful in the outside world.

4.3 Specific Features of the Intervention

The TPD around the Creative Process included four specific features common to all IEA interventions which will be explained hereafter:

1. Pedagogy determined by practice
2. Knowledge-building for social good
3. Learners' self, social, and world perceptions
4. Teachers as learners

4.3.1 Specific Feature 1: Pedagogy Determined by Practice

The first specificity is that the pedagogical process is determined by practice, in the sense that the intervention enables different applications depending on the topic taught, and the learning objectives that teachers intend to make connections to. Therefore, although teachers follow the same six phases, a physics teacher, for example, would select a different problem and learning objectives than a biology or chemistry teacher. This creates a climate of thinking and meaning-making by connecting the teachers more deeply with what they teach.

In addition, it enables groups of teachers to learn by sharing divergent views and mitigating the tensions that arise, creating a climate of thinking, reflecting, and questioning practices. This is important in all types of learning but more so in the case of teachers of refugees who work in isolation, providing an hour of core subjects a day. The process nurtures and promotes collaboration and builds on shared thoughts as the teachers consider how to integrate new ways of thinking and doing.

4.3.2 Specific Feature 2: Knowledge-Building for Social Good

The second specificity is that contrary to a traditional way of giving instructions, the programme combines individual and collaborative knowledge-building, self, and community

exploration to enhance a problem around teachers and students. It provides the ability not only to apply concepts in new situations but to contribute positively to the community. The focus is on creating something of value to the community which arguably, in the case of Syrian refugees living in Lebanon, brings new potentials to address their lack of status and disengagement from society, while simultaneously engaging teachers in knowledge-building.

4.3.3 Specific Feature 3: Learners' Self, Social, and World Perceptions

The third specificity is that it enables teachers to put themselves personally, emotionally, cognitively, and socially with others in the world, in communicative action, and to respect and value what is around them, and what they see in relation to the perspectives of others. It enables connections to be made that they would not otherwise make individually. This interrelation is the starting point of the exploration which stems from what learners bring with them as they connect deeply to themselves, to others, and to the community. Arguably, when teachers can make those connections themselves, they can design learning that is more relevant to students, building on children's lived experiences.

4.3.4 Specific Feature 4: Teachers as Learners

The fourth specificity is that teachers put themselves in a learner situation which helps them to question themselves, reflect on practice, and understand learners' perspectives. This arguably challenges deeply anchored beliefs about learning, pedagogy, and education.

One may wonder why such an intervention for refugees has been proposed in light of the complexity of the Lebanese context. Yet this process for refugee education is justified in order to:

- Uphold equity and quality learning for all, as per UNESCO's declaration (UNESCO, 2016, p. 8);
- Build teachers' capacities as transformative actors and strengthen practices without disrupting the overall school system, its organisation, and the complexity surrounding refugee learners;

- Strengthen mainstream learning with conceptual understanding, while leaving openness for learners to apply learning out of school and engage with concepts taught in class in real life;
- Bridge several of the challenges mentioned in Chapter 2 (context), such as learning with others and connecting with the community by enabling the intervention to sit alongside school learning, which gives flexibility beyond contextual constraints;
- Prepare refugees with the skills they need to build their lives. As stressed by Fraser (2003), refugees are vulnerable and those skills are even more relevant for them to build their futures. Thus, knowledge-building alongside interpersonal and social skills are arguably even more important for them to address the problems they will face to rebuild their lives and futures.

In summary, the Creative Process was created with a structured framework around knowledge-building to innovate and use technology to solve problems of the future (Scardamalia & Bereiter, 2005). It used open-ended questions such as “What can you do to help the growth of flora in your local environment?” to engage teachers around common community issues, to have them think in terms of solutions, and to make linkages with their subjects while integrating ICT. The intervention is described in Sections 4.4, 4.5, and 4.6, starting with the technological and pedagogical kits and followed by a detailed account of their implementation.

4.4 The Technological and Pedagogical Kits

This section describes the hardware, software, and pedagogical applications provided to schools, justifying their choice.

4.4.1 The Hardware

Schools that participated in the programme received Raspberry Pi stations comprising open-source hardware and software. The hardware consisted of RPi boards, power supply units (PSUs), secure digital (SD) cards, screens, mice, and keyboards. Electronic items included breadboards, light-emitting diode (LED) lights, and a variety of motors and sensors. The

combination of ICT is selected by virtue of necessity to bring the most powerful resources at the lowest possible cost. The RPi board is often used as a replacement to a regular computer with the aim of making computing as affordable as possible with open-source productivity and educational tools (Raspberry Pi, n.d.). The device is as small as the palm of one's hand. It is open, with an uncomplicated interface, and affords physical computing, thus allowing students to tinker, construct, build things, and engage with the world around them in educational projects, such as those seen in technology or innovation hubs. In previous experiences around the use of the RPi in learning (Hawker, 2015) with refugees, the RPi has been shown to be relevant in challenging contexts, cost-efficient, and sturdy, with practically no maintenance needed, thus lending itself to be used in the proposed context (Hawker, 2015). In addition to cost-efficiency, the software is open source with a thriving and supportive community which responds in a timely manner to all questions posted in its forums. The content and knowledge created by the community is shared and accessible to all users around the world which makes it appealing for knowledge-building.

4.4.2 The Software

The operating system on the RPi is a simplified version of Linux with preloaded open-source programming languages such as Scratch (<https://scratch.mit.edu/>) and Python (<https://www.python.org/>). The software taught in the intervention was Python and Scratch with a focus on their use in educational projects.

Python is a simple yet robust and powerful object-orientated programming language well suited to beginners. It is a dynamic language which uses clear and logical language performed at run-time by an interpreter; it highlights the code in different colours and reinforces the importance of accuracy and correct syntax. Python is used to teach programming in higher education (<https://wiki.python.org/moin/SchoolsUsingPython>) and taught worldwide in middle and high schools, providing a solid base to computational thinking (<https://www.stem.org.uk>). Python is

ideal as an introduction to object-orientated programming as it includes a turtle (a programmable screen object) such as the PC Logo programming language which enables those with little prior knowledge of programming to start developing programmes.

Scratch is developed and maintained by the Massachusetts Institute of Technology (MIT) and is a visual programming interface that serves as an introduction to programming for learners at all levels in education, primary, secondary, and tertiary education. The version of Scratch included with the Raspberry Pi has several unique features; one of the most useful is its ability to communicate with the GPIO pins (General Purpose Input Output). These pins allow learners to connect the RPi to a range of devices, from lights and motors to buttons and sensors (Raspberry Pi Foundation, n.d.). Combined with Scratch, it enables young learners to intuitively engage in programming and constructing physical objects.

Scratch's intuitive visual command blocks provide drag-and-drop functionality making programming accessible to learners of all ages. This feature is particularly attractive because it allows learners to also test projects as they create them. The script area is user-friendly and is based on graphical programming blocks that can be snapped together in the same way that Lego bricks snap together (Resnick, 1998). Sounds and graphics can be added, and projects can be shared and remixed with the Scratch community. In addition to developing computational thinking, Scratch has been used by teachers to teach science through simulations, visualisations, and animations, such as in projects around forces and motions or in mathematics and languages (Resnick, 1998). Depending on the objectives, students can play with the simulations or create their own applications and games in the process. Although Scratch, Scratch GPIO, and Python were taught in the intervention, the use of ICT was not limited to those. In addition, a variety of ICT tools which teachers were familiar with were used, such as the Internet, PowerPoint (PPT), videos, YouTube, WhatsApp, mind maps software, and Photoshop.

4.4.3 The Pedagogical Applications

In addition to the software to run the RPi, pre-installed pedagogical content developed for the intervention was pre-installed on the SD cards. The content included: (a) an offline version of the online guide with a series of tutorials (n=20) enabling participants to start independently even if they lacked connectivity; (b) examples with direct applications of the tutorials and open-ended problems for participants to practise with before learning how to develop their own projects. These applications were developed based on the concepts that science teachers had reported as challenging concepts to impart. A list of those applications is in Appendix K: List of Applications. In addition, an online platform was available which mirrored the content on the SD cards, providing a discussion forum for posting updates, asking questions, and sharing their future projects.

4.5 The Teacher Intervention

This section begins with an introduction explaining the intervention timeline and organisation. This is followed by a detailed description with an overview and account of its implementation.

4.5.1 Introduction

The overarching objective of the intervention was to enable teachers to design and engage students in a technology-enhanced, knowledge-building process. For a comprehensive list of objectives, please refer to Appendix L. The intervention consisted of six face-to-face, interpersonal workshops that enabled teachers to experience a full cycle of the Creative Process (CP). Activities included creating a community map, gaining insight into self, observing one's community, identifying and researching a problem, and designing and creating a solution. Technological skills were weaved into the pedagogical process to provide a continuum of learning and to enable teachers to select ICT tools based on their affordances.

As shown in the timeline presented in Figure 8, the intervention allowed teachers to first learn before designing a project. Once teachers had experienced the Creative Process, they

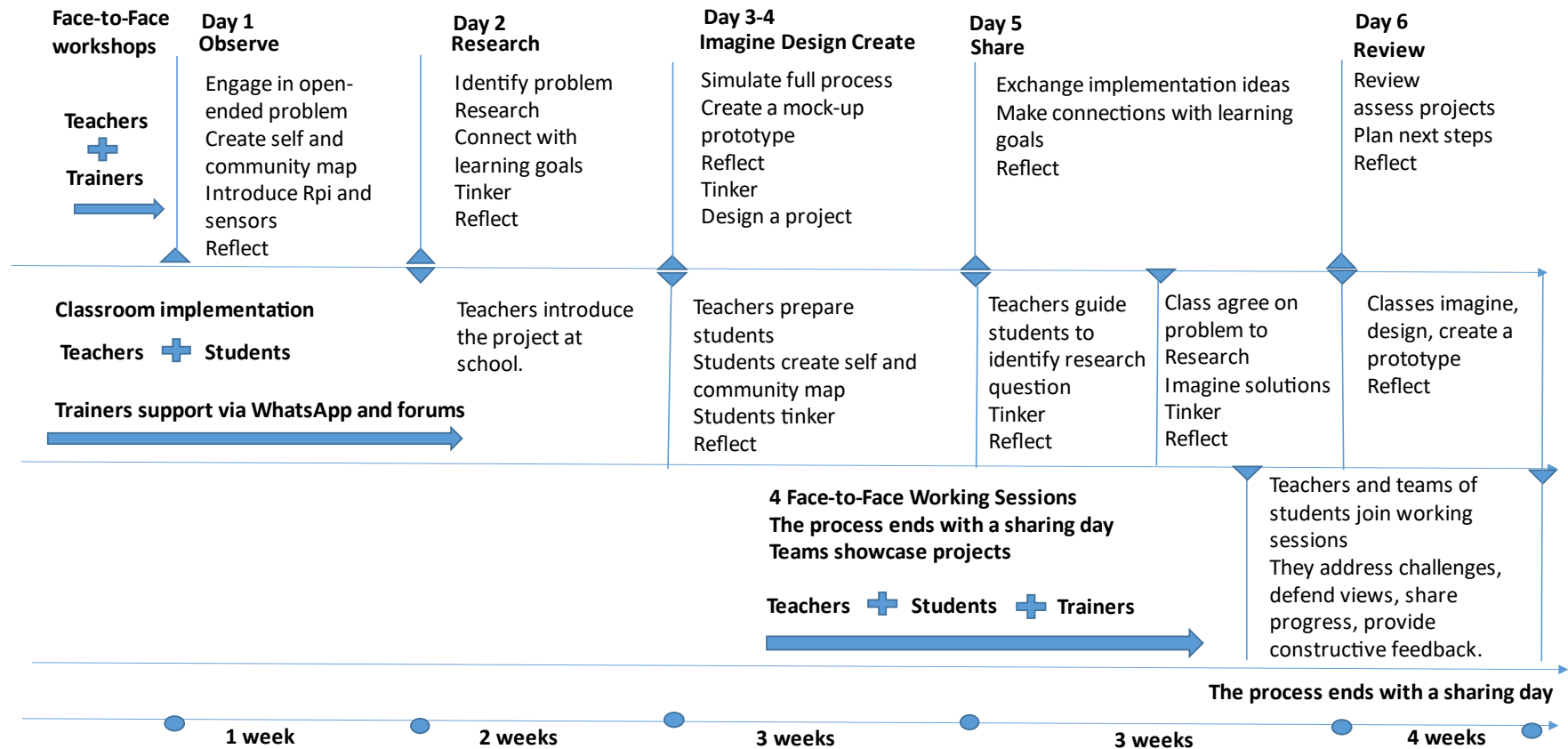
designed a project to implement with their students. As teachers guided their students, working sessions were held to support project work and teachers were required to book a place for their teams if they wanted to join one. Teachers reflected throughout the intervention and planned next steps. Two events were held, a Sharing Day and a Project Presentation Day at the Ministry of Education and Higher Education in Beirut, Lebanon.

The workshops were planned in such a way as to give teachers a head start of four weeks, to discuss the affordances of ICT, and to select what they were comfortable learning and using. In the meantime, they were asked to apply introductory activities with their students, such as creating their community map, engaging in open-ended challenges, and discussing the affordances of ICT. Although this was not planned, there was a delay in the delivery of the Raspberry Pi kits to schools which enabled teachers to allocate more time to the pedagogical aspect. However, the downside was that they had less time to practise and tinker.

As will be explained in Section 4.5.2, the intervention was repeated over two academic years to accommodate schools that registered late. Communication and support were planned via a forum on the IEA platform. Nevertheless, teachers asked to create a WhatsApp group where they could ask questions and receive responses in a timely manner. Thus, trainers created WhatsApp groups for their teachers, and teachers used them to sustain the conversation past the workshop, to ask questions, and to exchange messages and pictures of their work. A schematic overview of the intervention activities and timeline is presented in Figure 8.

Figure 3

Schematic Intervention Activities



4.5.2 Intervention Overview

The selection of schools was conducted in close collaboration with the Ministry of Education to include those with the highest number of refugees. Schools were sent information about the intervention and two teachers, of sciences and computer studies, were invited to register for the workshops. A final count of 42 teachers from 21 schools registered and the launch of the programme was held at MEHE on 6 February, 2017. The intervention started on 18 February, 2017, with an informative session centrally hosted in Beirut. It was followed by workshops in each region. Additional meetings and interviews were held with principals and students, and pre- and post-questionnaires were sent to teachers. These meetings, interviews, and questionnaires were part of the larger IDRC study and remained beyond the scope of this research.

Interviews with teachers were held in schools (n=9), midway into the programme. Conversations with teachers took place during working sessions held by IEA facilitators with support from engineering students who volunteered to support the technical aspects and project work. The intervention was free of charge and teachers had to commit to completing the six days. Working sessions were not mandatory but teachers had to register before joining one.

At the end of the academic year, all participating educators and students interested and willing to share their projects were invited, without any obligation, to a Sharing Day held in Beirut on 20 June, 2017. A debrief session was held in October 2017 with all teachers and was followed up by interviews in the same schools where the mid-programme interviews took place. Upon the request of the Minister of Education, who was interested in hearing first-hand from participants about their experience, participants were invited to the Ministry of Education on 12 January, 2018, to present their projects. Teams of students, accompanied by their teachers, presented their projects in front of an audience of officials from the MEHE and the Centre of Educational Research and Development (CERD). In parallel, debrief sessions were held with all trainers and the teams of volunteers supporting the project's technical needs. Workshops and

working sessions continued to be offered in 2018 for those who were unable to participate. In addition, all teachers and students were invited to participate, if they wished, in the annual Lebanon Raspberry Pi competition, which was held in Beirut on 24 March, 2018.

4.5.3 Organisation of the Intervention

In light of the number of teachers (n=42) registered in the programme, on the first day, teachers were divided into two groups of 21. The workshop was held centrally in Beirut in a school from 9:00 a.m. to 12:00 p.m. for the first group and from 1:00 p.m. to 4:00 p.m. for the second group of teachers. Subsequent workshops were held regionally at partner institutions to reduce the time spent travelling for participants. Thus, after the first day, participants were regrouped by location, enabling them to learn in smaller groups. Partner institutions were Beirut Arab University (BAU) Tripoli Branch, the Holy Spirit University of Kaslik' (USEK), the American University of Science and Technology (AUST), the Hajj Bahaa Eddine Hariri School (HBS), the American Community School at Beirut (ACS), and the Beirut Digital District (BDD).

Four working sessions were held regionally and two centrally at the BDD. The Sharing Day and final project presentations were held in Beirut at the BDD and MEHE respectively. After starting the programme, the number of participants fluctuated and often supervisors or administrators accompanied teachers. In addition, seven schools were replaced for reasons beyond the researcher's control. Hence, there were two groups of teachers: Group A, which started in February 2017 and Group B, which started in December 2018. Table 1 provides an overview of the participating schools.

Table 1*Number of Participants in the Intervention*

Group	Academic Year	Number of Schools	Number of Teachers
A	2017–2018	13	24
B	2018–2019	09	18
	Total	21	42

Teachers who participated in the 2017–2018 programme continued to work on projects in the 2018–2019 academic year. The workshops for group B followed the same sequence as group A. When working sessions started, Group A and B teachers were invited to join them if they wished.

4.5.4 Trainers

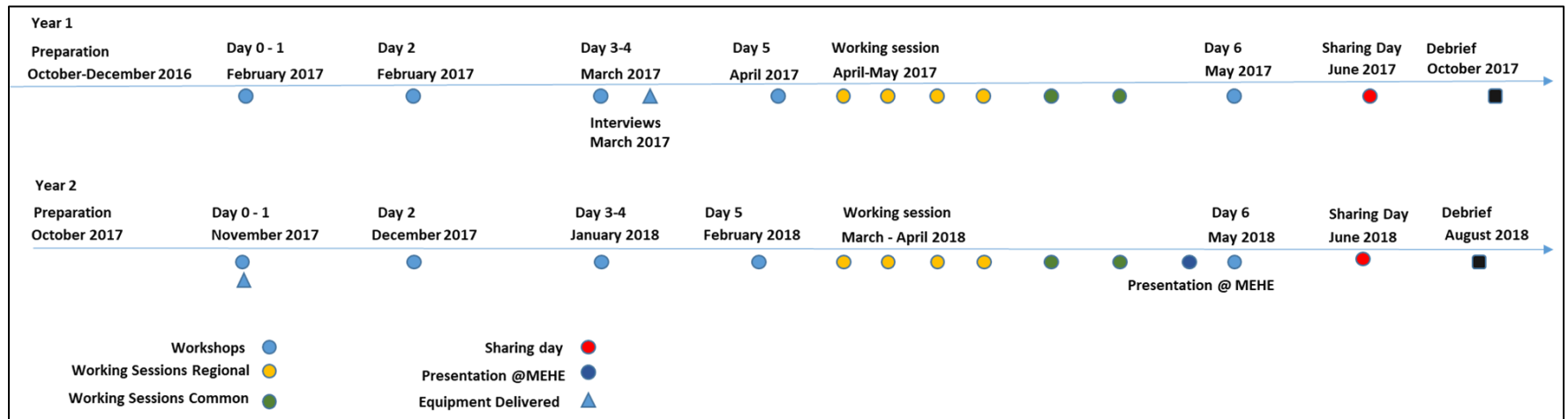
The intervention was delivered by five IEA trainers, one in each location and 15 volunteer engineering students, two to three assigned per location. Volunteers provided technical support during workshops and working sessions.

4.5.5 Timeline

Figure 9 provides an overview of the intervention timeline and is followed by Table 2 containing a summary of the intervention organisation. Further details about participants are given in Section 5.3.

Figure 9

Overall Timeline



Note. The circles reflect the workshops, working sessions, and Sharing Day and the triangle refers to the distribution of equipment.

Due to heavy bureaucracy, the preparation took longer than expected and the programme only started in February 2017. In addition, although IEA planned to deliver the RPi kits to schools at the start of the programme, the shipment was delayed in Year 1 due to unforeseen circumstances.

4.6 Description of the Intervention

The following six days, with slight organisational variations, were repeated for Group A and B teachers.

Table 2*Intervention Organisation*

Day	Intervention Details	Hours	Who	Location
0	Morning	3	Teachers	ACS
0	Afternoon	3		
1–6	Full day	6	Teachers	BAU, USEK, ACS, AUST, HBS
4	Working Sessions	4	Teachers and teams of Students	BAU, USEK, ACS, AUST, HBS
2	Working Sessions	4	Teachers Students	BDD
1	Sharing Day	3	Teachers and teams of students	BDD
1	Project Showcase	4	Teachers and teams of students	MEHE

The workshops, working sessions, Sharing Day, presentation at MEHE, and four projects are described in the following Sections.

4.6.1 The Workshops**Day 0**

An informative day was held at ACS and started in a central hall with adjacent rooms for small group discussions. The meeting started with an icebreaker and a presentation of the intervention objectives, and was followed by a group interview entitled “your views”, with the purpose of engaging teachers to express their views about pedagogy and ICT affordances. The

aim of the interview was to provide an open space for teachers to express their views before starting to learn. It also provided them with the opportunity to raise questions about the programme.

Teachers formed groups of four to discuss their thoughts and a representative from each group reported back to the larger group, giving a summary of the main discussion points. Essentially, teachers expressed their doubts and fears about their ability to succeed in the programme and they were reassured that they would be guided throughout the process. The intervention objectives were discussed, and sample applications were shared with teachers. The process took around 90 minutes and was followed by an overview of logistics and the timeline of subsequent workshops.

As explained in chapter 1, the intervention was implemented in morning shift schools with intermediary and secondary schools because there were no secondary-level classes open in the afternoon shift. There were two exceptions where intermediary-level schools sent a primary-level teacher. Teachers grouped themselves per region to meet the team of trainers and volunteers. Following the introductory meeting, teachers were invited to join face-to-face workshops which were delivered in five locations (Beirut, HBS, USEK in Mount Lebanon, Tripoli, and Bekaa). Three schools, that could only send one teacher to the workshops, sent school administrators. In addition, three principals joined all the workshops with their teachers. I attended all sessions in one location (USEK) and the common working sessions in Beirut.

Day 1

On Day 1, teachers introduced themselves and created a community map using cardboard. They included their backgrounds, interests, passions, educational experience, and views about learning. They expressed and presented what their community represented to them, how they fulfil their interests in their community, and discussed their views. A fun challenge followed to introduce open-ended questions. In groups of four, they built the highest possible paper tower which could hold a heavy object. Groups were given the same amount of

paper, a pen, a strip of masking tape, and the same heavy object. Participants were not allowed to speak during the activity; they could use gestures or writing to communicate and had to share with trainers a sketch of their ideas on paper.

A discussion followed about their hypothesis and the scientific concepts included in their tower, how the group communicated, and what they would do differently next time. There was a lot of excitement in the room. Pedagogy was discussed with particular attention to questioning, open-endedness, group dynamics, and how they communicated and relied on each other. The discussion transitioned to how simple open-ended problems might work in their classrooms using the example of the “school safety sign” application. Teachers initiated different types of open-ended problems the application may address such as “How can schools be safer for students?” The discussion continued around what it means in practice, how to engage students, the balance between individual and group work, and activities that may be applied in or after school.

In addition, the first day included an introduction to the technology alongside passive circuitry using batteries and jump wires before transitioning to LED lights and breadboards. They engaged in hands-on activities and were introduced to the technology kits and coding (either on Scratch or Python). Teachers discussed and selected Scratch or Python depending on their speciality, interests, and grade levels. The day ended with a wrap-up of all activities, a review of the timeline, the technology, and teachers’ reflections.

Day 2

On the second day, teachers continued their community maps and explained how they made meaning of the concept of community. Open-ended community problems were discussed and the “Greenhouse” application was used as an example. Linkages were made between the application and the question, “How can we help the flora in our environment?” It was followed by a discussion around how such a project may enhance learning, the concepts that are embedded in the project, and the skills that students would gain by engaging in it. The afternoon hours

were dedicated to hands-on experience with technology and ended with a non-technological activity. Teachers created a car that could move from point A to point B with reused items such as cardboard, bottle caps, wooden sticks, and masking tape. They were also asked how those concepts in the activity relate to their subject area. Teachers started a simulation of the Creative Process cycle and in groups of three or four identified a community problem to research.

The day ended with reflections and a discussion about how to share their work at school and how to engage Syrian students in the project. It appeared to be complicated for teachers because Syrian students were distributed at various levels and in various classes. They were asked to form groups of five students and to ensure that at least 50% of them were Syrian children. Several teachers were not teaching refugees in the classroom and went to great lengths to engage students during breaks and after school. Logistically, they worked hard to ensure that they were working with refugees, and principals supported the process.

In one of the schools, the teachers, with the permission of their principals, engaged afternoon-shift children, and conducted activities after school to enable them to engage in the project. There was one exception with a teacher who resisted engaging refugees and said that refugees could not understand the process nor manipulate the technology. She selected a group of four Lebanese students with high grades and engaged one Syrian student. In addition, Group A teachers expressed their worries about the delay in receiving the technology kits which prevented them from practising and gaining confidence to teach it. Group B teachers did not face the same issue as the kits were delivered prior to the start of the 2018–2019 academic year.

Day 3

The third day started with a conversation between teachers about the process, the delay in receiving the kits for Group A, and their lack of practice which stressed most of them. The delivery of the RPi kits and sensors had started arriving in several schools (n=7). The intervention was adapted to give teachers more time to practise and tinker with the RPi and

sensors, and teachers continued to engage in the CP cycle which continued on Day 4. Day 3 ended with teachers' reflections on the process.

Day 4

The fourth day started with a debrief of the previous day. Teachers had to complete a mini-project which enabled them to apply the acquired skills. They continued to work in groups and transitioned to the simulation of the complete cycle of the CP. They worked in groups, had to sketch their designs, create a solution, and give constructive feedback to each other. Teachers said that the simulation helped them the most to understand the process and expressed their surprise as to how groups were able to generate ideas and create a solution. Time was dedicated to learn to design open-ended projects. Two examples were used: "How can we help the flora in our environment?" and "How can schools be safer for children?" Teachers were asked to prepare their students and design their own project. The day ended with reflective comments from teachers and a summary of what they needed to complete before the next workshop.

Day 5

On the fifth day, teachers shared their project designs and discussed implementation. Teachers continued to practise their technical skills, and shared challenges and how they mitigated them. Finding the time to work with students was complex with their packed schedules and almost all of the teachers (n=38) had already introduced the project to their class and started working with smaller groups of five during school breaks. With support from the principals, schools (n=23) opened after school hours for students to learn and work on their projects. Organising groups was a complex matter for schools and teachers, as one of them included students from the afternoon shift. When students worked after school hours, teachers (n=5) organised project work after students had completed job-related duties. Teachers mentioned that parents (n=5) of Syrian students started visiting schools to know more about the project as they were puzzled with the change in their children's behaviour. Additional

administrators and school leaders (n=4) joined the fifth workshop and subsequent working sessions, mentioning that this was because they were puzzled about students' motivation to learn and work on their projects. During this phase, communication via WhatsApp was sustained, teachers exchanged screenshots of their communication with students, asked questions, and reported on their progress.

4.6.2 Working Sessions

Upon the request of the teachers, working sessions started earlier and teachers brought teams of up to five students to work on their project. Four sessions were held regionally and were attended by approximately 150 participants grouped in teams of approximately five students led by 30 teachers. Teams arrived around 9:00 a.m. with their project and worked intensively on their projects until 3:00 p.m. The sessions followed the same format and started with groups sharing their progress and ending with reflections and next steps. During the sessions, teams brought their own materials and equipment and were fully responsible for their project. Trainers and facilitators were assigned to teams and discussed project work with students who defended their proposed solutions and explained the stumbling blocks they were facing.

During working sessions, I spoke with teachers and observed them working with their students on projects. At the start of every working session, a collaborative hour-long conversation took place with participants to elicit their reflections, share what was working or not, how the process spoke to their practice, how they were mitigating problems at school, and how their project work was evolving. Based on teachers' requests to get to know all participants and to ensure that they had all completed their project, two additional working sessions were held centrally at the BDD in an open hall. It was attended by approximately 20 teachers and 100 students. Participants registered before joining and were assigned to a table, and teams went directly to set up and start working on their project. They worked with the volunteers who had supported them previously and trainers circulated between the projects.

Day 6

After completing project work, teachers met again to reflect on the full process, assess project work, and plan next steps. Rubrics were used to assess project work and reflections took place in the form of group conversations. The process was facilitated by IEA trainers. In pairs, teachers reflected for 40 minutes on their own work, the skills they had gained, and their project work with students. Reflections were shared in a larger group conversation and teachers commented on and proposed next steps.

4.6.3 The Sharing Days

The sharing days were held in June at the BDD. All teachers were invited and an average of 20 teams of five students accompanied by their teachers joined the event respectively. Many schools invited their principals and asked if they could invite additional teachers from their school and parents. The days were facilitated by IEA and school teams arrived around 9:00 a.m. They had to find the table allocated to their school and set up their project by 10:00 a.m. A group came with a poster explaining their future project plan and what they had learnt from any project failures. All the other groups had their prototypes set up on tables to share their projects. After a quick welcome by BDD officials, the peer review process was explained, and teams were given a peer review rubric. A set time was allocated for teams to circulate between the tables, peer review three projects, and take notes on paper. Once teams had completed the review, they returned to their tables and had 15 minutes to debrief before submitting their review online using Mentimeter (<https://www.mentimeter.com>) with results showing instantly.

4.6.4 Presentations

At the end of every project cycle, IEA brings together participants to showcase and celebrate their learning. The event was held at the end of the 2017–2018 academic year. Exceptionally, the Minister of Education and Higher Education invited teachers and students to showcase their work at the Ministry of Education in front of an audience of officials. It was

attended by 14 teams consisting of 70 participants and 28 educators, who arrived at 9:00 a.m. to set up their projects. The event started at 10:30 a.m. and ended at 1:00 p.m. The minister, a delegation of officials and guests circulated amongst groups, asking them questions about their projects, what they did, why they thought their project was important, and how they had completed it. One group came unaccompanied by their teacher, who had faced unforeseen circumstances, and presented a mind map of their project because they could not carry their project on public transport. The projects shared are listed in Appendix M and four projects are described next in Section 4.6.5.

4.6.5 Four Projects

4.6.5.1 Smart Glasses for the Visually Impaired. Ali is a computer teacher in a school situated in a highly conservative region in the Bekaa Valley. He joined the intervention in Year 1 and continued into Year 2, unaccompanied by the science teacher with whom he had collaborated at school. Ali had no previous knowledge of Scratch or Python and no experience with educational projects.

He started teaching Scratch and Introduction to Python in the computer lab to intermediary and secondary classes respectively. He designed a project with a team of three Grade 10 and 11 Syrian male students, and two Grade 9 and 10 Lebanese female students. The two females were sisters and one of them, Aicha, suffered from a visual impairment. She was mocked by other students when she bumped into people or things. Ali and his team of students decided to address the problem of Aicha's visual impairment. They started with the aim of creating glasses that could tell the user what they see. Ali met at length with the biology teacher and led the team's work. Their investigation revolved around the eye, and the nervous and sensory systems.

They decided to design a project that could help Aicha to cope with her visual impairment. If she had a practical pair of glasses that could tell the distance between objects relative to her position, she would be able to move independently. Students conducted research

and had several hypotheses which they tested using an ultrasonic sensor and a motor that vibrates at different intensities from an obstacle at 3, 1.5, and 0.5 m. They made several sketches and designs before installing the sensor on a secondhand pair of sunglasses, which Aicha used at school.

The team selected by Ali to work on the project were not his best students. He included Samir, a 16-year-old Syrian student, labelled as “a thug”, who had dramatically failed his subjects and had been expelled from most classes. After coming to Lebanon, his parents had divorced, and he lived with his mother. Samir’s punishment was to join the project team. The teacher explained that the project saved Samir from falling into the grip of drug dealers. With support from his peers, Samir started studying, passed his subjects, and led the project. The teacher explained that Samir’s father came several times to enquire about his son’s work on this project, especially as the team continued working after school hours and sometimes in the evening at Aicha’s parents’ home.

4.6.5.2 Detector of Two Persons in a Toilet Cabin. Amira and Randa teach physics-maths and humanities respectively, in a middle public school in Jbeil. Amira and Randa had no previous experience with the ICTs used in the intervention and educational projects. In addition, Randa provided psychosocial support to Syrian students at school. They joined the intervention in Year 1 and expected support from the computer teacher. With no previous ICT experience, Randa selected Scratch and Amira selected both Python and Scratch. Their team of students consisted of four Syrian middle-school male students and three Lebanese students, two females and one male.

The teachers designed a project to stop sexual harassment in public school toilets to prevent older children from abusing younger ones. The idea appeared to be extremely challenging, but they felt excited by the encouragement of colleagues during reflective moments. The idea was welcomed less by officials because it addressed a problem that is not spoken about in schools. However, the comments during the workshops stimulated them and

they sustained their project asking themselves, “How might technology be used to detect two persons in a school toilet?” The physics teacher worked with all of the students in class and met regularly with those working on the project during breaks and after school, mostly on Saturdays, when two of the Syrian students were not working.

During the physics lesson, the teacher explained the use of sensors, motors, and ultrasonic waves. Students tried to find out what type of sensor might detect two persons in a toilet. The team created a mock-up of the toilet cubicle with cardboard but ran into a stumbling block as they were unable to find a solution. During working sessions, they were asked to return to the design phase and illustrate their hypotheses. The illustration revealed that students had a flawed understanding of how ultrasonic waves travel. Amira engaged them again in the concepts, which were then resketched. With every sketch, hypotheses were discussed and explored with “what if” scenarios until one of their hypotheses was plausible and they were able to complete their mock-up before coding it. The two teachers had little to no help from the computer teacher and continued learning into Year 2.

4.6.5.3 Safe School. Fatima joined the intervention in Year 2. She was tech-savvy and had extensive previous experience with ICT in educational projects. In 2022, she was appointed acting principal of her school.

Fatima worked with her class during school hours and with a group of five students after school hours. The team of five comprised refugees from Syria (n=2) and Sudan (n=1) and two Lebanese students. They were of mixed abilities: some were badly behaved, were referred to in school as “hooligans”, and had difficulty expressing themselves. Fatima and her students communicated via WhatsApp. Hence, she could follow her students’ communication even after school hours.

Students decided to work on safety around their school because of the large number of car accidents that occurred in front of the school gates. They decided to create a smart hump that would block cars from passing when children crossed the road. They designed the project,

and created and coded a prototype. They created what looked like a perfect prototype which they brought to working sessions. Through discussions with trainers during working sessions and after consultations with the mayor, they realised that the project was not viable and might even be harmful.

The students reflected on the process, their thinking, how they made decisions, the lack of research, criteria, how they jumped to conclusions, and how they rushed to start building and coding the project. They had not unpacked the problem or hypothesised a “what if” solution. They decided to start again, this time on the right track, and invested themselves in investigating the problem of congestion in the tunnel next to their school. They were surprised to discover the story behind the tunnel, and researched and met with experts, engineers, and municipality officials.

They investigated the number of accidents that happen annually, the length of time that people waited in the tunnel, and the level of air pollution during those hours. They had first decided to create a system that would warn people of congestion and encourage them to avoid taking the tunnel but instead focused on air pollution and its impact on the health of those stuck in the tunnel during congestion. They planned, conducted research, and hypothesised several “what if” scenarios but completed their project after the Sharing Day. On the Sharing Day, Fatima’s students made a poster presentation, in which they explained what they had learnt from the project failure.

4.6.5.4 Robot Vacuum Cleaner. Hoda taught science in a secondary school in Beirut and chose to join the workshop to improve her skills. Hoda had no previous knowledge of ICT and was close to retirement age. In addition, she often referred to personal and health issues, which caused her stress. She was the only teacher from her school to join the workshop and there was no computer teacher to support her. She rarely engaged in collaborative activities with other teachers. There was no classroom implementation as she could not see a connection with her teaching.

She selected the highest achieving students – those with the highest grades – and formed a team of four with three Lebanese students and one Syrian student who rarely joined the team during working sessions. Hoda worked hard to learn Python and circuitry. She took the equipment home to practise and printed instructions to teach her students how to use the RPi and the sensors. She saw no connection with her learning goals and worked with students during school breaks. The problem selected was how to keep the school yard clean. She discussed potential solutions with her students, and they decided to create a robot vacuum cleaner to pick up the rubbish left by students in the yard. She tested and implemented a prototype at home before printing instructions which she repeated with her students. She completed the project and participated in all events.

5 Methodology

This chapter presents the theoretical and epistemological perspectives used in this research, discusses the methods and process employed for data collection, and analysis. Finally, reflexivity, validity, ethical considerations, and the limitations of the research are presented from the perspective of my position as researcher practitioner.

5.1 Theoretical Perspectives

Research is grounded in what one aims to know and the drive from which one stems which in this research is focused on understanding a phenomenon in a specific context (Creswell, 2007 p.3). The proposed research methodology is qualitative and informed by socioconstructivist and interpretivist epistemologies with an orientation influenced by critical theory. Lather (2006) situates paradigms with insistence on multiplicities and proliferations and refers to dualistic categories, arguing against a linear sense of development towards “one best way” and “consensus” approaches. While I do not attempt to combine paradigms, I agree with the nuances between them as referred to in the literature, and in Section 5.2, I explain this influence and the choice of qualitative research methodology.

5.2 Qualitative Research

5.2.1 Introduction

Qualitative research is grounded in the deep appreciation of the sociological constructed nature of reality with an emphasis on the underlying processes and their implicit meanings (Hammersley & Atkinson, 2007, p. 145). The choice of a qualitative methodology to answer the main question and sub-questions that drive this research is justified to interpret and make sense of the meanings that participants bring to a complex phenomenon. The research question is: “What learning is fostered when Lebanese teachers engage in a technology-enhanced learning (TEL) intervention with refugee children?” The sub-questions are as follows:

1. What are teachers’ perspectives on the learning intervention and how does it relate to their practices?
2. How are teachers experiencing this learning intervention, what is working or not, what tensions are they experiencing, and how are they mitigating them?
3. What was the process like for students to think and create their artefacts and how does it relate to their learning?
4. What value do the artefacts represent to the students, teachers, and principals?

Generally, research links expected research outcomes to research questions (Crotty, 1998, p. 3). However, with the exploratory mode of interrogation framed by the question “What?”, I went into the field without predetermined expected outcomes to find out, with and from teachers, what is happening and what learning is fostered when they engage in a TEL intervention in this context. Over time, the missing gaps in the literature led me to focus on teacher agency in practice, what drives it, and how it manifests itself. As explained by Creswell (2012), exploratory researchers tend to enter the field with no prior judgement or a set of surveys and questionnaires to deploy, as is generally the case with quantitative methodologies. Thus, this open frame of mind and mode of interrogation allows the exploration of teacher agency and the enabling of new questions to emerge from the field.

Exploratory modes of research relate to the nature of the problem and the aim of understanding relationships and processes (Creswell, 2012). An example cited by Creswell (2012) is Sheldon et al.'s (2010) research who employed a qualitative research methodology to gain insight into trust relationships between schools and parents. Additionally, the literature around TPD and agency includes rich exploratory research that examines the intricate relationship within TPD and between teachers and systems. Jones and Charteris (2017), for example, used exploratory modes of research to examine reflective practices and agency, while Zhang and Dempsey (2019) explored assessment tools to measure transformative learning.

Similar to exploratory research and with the “aim to study the nature of a problem and develop a detailed understanding of its central phenomenon” (Creswell, 2012, p. 13), this research aims to understand teachers’ agency when they engage in a low-cost, TEL intervention with refugees. In line with this aim, I follow Creswell’s types of research design and view agency as a central phenomenon requiring exploration and understanding (Creswell, 2012, p. 423). Considering the nature of the target phenomenon (i.e. agency), I ascribe to the advice of Corbin and Strauss (1990) who explain that “qualitative methods can be used to obtain the intricate details about phenomena such as beliefs, thought processes, norms, values and feelings that are difficult to extract or learn about through more conventional methods” (Corbin & Strauss, 1990, p. 11).

Creswell maintains that qualitative research is characterised by the fact that (1) variables may emerge from the field; (2) the purpose and research questions are stated in a general way; (3) data are collected based on words from a small number of individuals so that the participants’ views are obtained; (4) data are analysed interpreting the larger meaning of findings; (5) the report is written using emerging structures including researchers’ subjective reflexivity and bias; (6) one needs to learn more from participants through exploration, particularly if the literature yields little information about the phenomenon of study (Creswell, 2012, p. 13).

Those characteristics are well suited to this research which investigates the agency in practice of a relatively small group of teachers (n=42) in a TEL intervention in the context of refugees. In comparison with those characteristics, this research (1) does not single out one variable to study but allows the data to emerge from the field; (2) poses the question very broadly to allow new questions to emerge from the field depending on the experience and perceptions of participants; (3) collects data from a relatively small group of participants, bringing in their perspectives about the intervention and highlighting the cases that shed light on the phenomena; (4) analyses the data within the triangular and dynamic relationship between agency, structures, and cultural practices, which requires deeper interpretive and analytical skills rather than taking things at face value; (5) enables the researcher to report based on emerging themes and to address my own subjectivity as an insider researcher; (6) considers participants in the research as the main sources of information. This is particularly pertinent since there is relatively little literature on the phenomenon of teaching refugee learners in using TEL.

5.2.2 Situating the Research Paradigms

Moving from a positivistic epistemological emphasis on cause and effect, Silverman (2000) and Stake (2010) describe qualitative social inquiry as non-deterministic and constructivist with a holistic approach to deep and personal explanations of phenomena. Stake (2010) further argues that humanistic and interpretive qualities are required to understand coincidental actions within intricate situations (Stake, 2010). Creswell (2007) further maintains that qualitative research is multi-method in focus, involving an interpretive, naturalistic approach to its subject matter (Creswell, 2007, p. 4). As stressed by Stake, unravelling those meanings requires a deep understanding of the temporal and spatial, historical, political, economic, cultural, social and personal context (Stake, 2000). Those characteristics situate the research within socioconstructivist and naturalistic interpretivist epistemologies. Socioconstructivism as explained by Bryman (2004) is an ontological position, which “asserts that social phenomena

and their meanings are continually being accomplished by social actors” (Bryman, 2004, p. 33). It is based on the belief that knowledge is socially constructed and that people play an active role in the construction of their reality (Scott & Usher, 2011). From a constructivist perspective, examining the “social and cultural” reality of people helps us to understand their perspectives (Crotty, 1998 p. 54). Indeed, constructivists believe that different people construct meaning in different ways, even if they have the same mutually engaging experience, which arguably renders the role of communicative action (Habermas, 1985) in teachers’ dialogue around their lifeworld significant because it enables teachers to exchange their perspectives around their experience (Habermas, 1985).

According to Creswell (2012), qualitative research is “interpretive” since the researcher brings a “personal assessment to a description that fits the situation” (p.238). As opposed to postpositivism, which often seeks for the discovery of universal theory or truth, interpretivism accepts and seeks multiple perspectives (Cohen et al., 2007 p.21). Indeed, teachers construct their own perspectives, and bring their realities and context in a way that their learning becomes a product of the activity, their context, and culture. Interpretivists believe that there is no particular right or correct path to knowledge, no special method that automatically leads to intellectual progress (Smith, 1993). Interpretivist researchers approach the reality from people who are experiencing this reality and do not seek rigid answers to their study. Interpretivist researchers understand “the world of human experience” (Cohen et al., 2007, p. 36) and affirm that it is critical to understand the “context” in which research is conducted to interpret the data gathered (Cohen et al., 2007).

With an understanding that human behaviour is continually constructed, and reconstructed, based on people’s interpretations of the situations they are in, interpretivist researchers discover reality through participants’ views and their own background and experiences (Creswell, 2012). This applies to this research which aims is to understand teachers’ interpretation of the intervention and their post-implementation action.

Constructivist and interpretivist epistemology are related in the sense that they aim to understand the complexity of lived experiences from the point of view of those who live it (Scott & Usher, 2011) and portray a world in which reality is socially and culturally constructed, complex, and ever changing. Cultural practices include the routines teachers engage in in their everyday lives, their beliefs, including norms and values, and their feelings and emotions, and can be defined as patterns of social and cultural interactions and behaviours which represent the knowledge of what to do, when and where and how to interact within a particular learning culture (Street, 2015, p.7). Street (2015) proposes that we think of culture as a verb rather than a fixed thing.

The dynamic and unbound attribute of culture is in line with Mezirow's (2000) transformative theory, and the way participants continuously construct and shape their frames of minds and beliefs, which in the process, forms their sociocultural context. This construction happens over time in an iterative process of communicative action, around the four stages of experiential learning, and may be captured, through spending time and interacting with participants in the field during the intervention, to develop understanding of their social reality. As explained by Yin (2018), the fact that I have designed the intervention and spent time with participants during the intervention provides insider perspectives and requires reflexivity (Yin, 2018) which is explained later in this chapter Section 5.2.4.

As part of the fieldwork, I have participated in all face-to-face interventions, conducted two visits to interview teachers in nine schools, and engaged in unstructured and unsolicited interaction with participants during the intervention. This type of "unstructured and unsolicited time spent to discern social situations" suits the explorative nature of the research, which allows data to emerge from the field, to document and interpret distinctive ways of practice (Hammersley & Atkinson, 2007, p.99). In terms of data collection, in addition to eliciting unsolicited data, it allowed me to observe what happened, to interact naturally and recurrently with participants, to ask questions and clarify meanings in the process, and to throw light on the

issues that were emerging. Thus, despite the risk of insider bias as explained by Yin (2018), it enriches the constructivist interpretive approach, whilst still requiring rigour in reflexivity and validity.

Finally, there is the influence of critical theory in the research since the intervention involves teachers of Syrian refugees who were forced to leave their country because of the war. Critical theory argues that all knowledge is “historical and broadly political in nature” (Friesen, 2008 p.1). This is even more so in the case of refugee education. Critical theory is rooted in social justice and aims to problematise “what is taken for granted in culture, especially in the interest of those who are oppressed” (Nichols & Allen-Brown, 1996, p. 226). It questions interests and motivations while aiming to destabilise what is taken for granted or what Friesen refers to as “myths” (Friesen, 2008, p. 1). As explained by Friesen, critical methodology “operates comparatively, by measuring consensual truths against actual social conditions” (Friesen, 2008, p. 2).

Critical theory includes perspectives drawn from marginalised or oppressed groups, “feminist thought, racial views, sexual orientation” (Denzin & Lincoln, 2011 p. 217). While generally, critical theory aims to induce change and action, it is worth reiterating that the objective of this research is to contribute to knowledge and understand the phenomenon of teacher agency in practice in a challenging context (Hammersley & Atkinson, 2007). On the other hand, the influence of critical theory in this research implies that as a researcher, I needed to avoid instrumentalist or simplistic interpretations of the collected data, and dig beneath the surface, while being equally sensitive to issues that are salient to teachers of refugees and refugee learners in a knowledge-building process with ICT. These may include having access to knowledge-building processes, being at risk, or whether the use of technology is a barrier rather than an enabler to engage in learning.

In sum, I believe that the socioconstructivist and interpretive paradigms are well suited to the aim of the research and provide grounds to develop methods to analyse and interpret the data.

5.2.3 Case Study

Amongst the various genres which qualify as qualitative, the case study depicts a phenomenon within a defined bounded context (Miles & Huberman, 1994) and is “employed to gain an in-depth understanding of the situation and meaning for those involved. The interest is in process rather than outcomes, in context rather than a specific variable, in discovery rather than confirmation” (Merriam, 1998, p. 19).

According to Yin (2018), case study research comprises an all-encompassing mode of inquiry, with its own logic of design, data collection techniques, and specific approaches to data analysis that can accommodate a relativist perspective with multiple realities and meanings, and is in line with the constructive interpretive paradigm chosen. Yin suggests that the exploratory mode is the most adapted to “what” questions for events that are current, such as the intervention, whereas “how” and “why” questions are more explanatory. He also suggests that the three modes, descriptive, exploratory, or evaluative, can be overlapping or distinctive. I contend that the exploratory case study as a research mode is well suited for the real-world nature of this research because it enables an examination of in-depth “teacher agency” and a consideration of the intricate relationships around teachers’ individual and group behaviour in TPD and in practice. Furthermore, Merriam (1998) asserts that the essence of a case study is to investigate, in depth, a contemporary phenomenon (the “case”) within its real-world context, especially when the boundaries between phenomenon and context may not be clear, to illuminate a decision or set of decisions: why they were taken, how they were implemented, and with what results.

In addition, Yin emphasises six points of traditional concerns which are presented with how they relate to this research:

1. *Rigour*: as explained by Yin (2018), case study research, starting from the literature or the field, requires a rigorous methodological path to cope with a technically distinctive situation, in which there will be many more variables of interest than data points. In addition, the theoretical propositions should guide the design, data collection, and analysis, and results should rely on multiple sources of evidence, with data converging in a triangulating fashion. These principles were applied in this research, which started in the field with rigorous coding and organisation around the data which was first explored, described, reflected upon, interpreted and organised under the analytical sociocultural framework.
2. *Generalisation*: of a theoretical proposition rather than transferring a process, so the goal is therefore to expand theory and analytical generalisation rather than extrapolating statistical probabilities (Yin, 2018).
3. *Set case and boundaries*: the essence is to define the “case”, which in this research, is “teacher agency in a situated intervention” studied based on theories and set boundaries.

From the various strategies suggested, the boundaries included are:

- temporal (two academic years) (Yin, 2018, p. 71)
- spatial (intervention location) (Creswell, 2012; Yin, 2018 p. 71)
- real-world phenomenon/activity (experiential) (Stake, 1995; Yin, 2018, p. 71)
- context (refugee education in Lebanon) (Miles & Huberman, 1994)

Although a “multiple-case study approach would be invaluable”, the research aims to bring about teachers’ collective experience during the intervention with examples of what teachers reported during interviews and conversations (Yin, 2018, p. 44). Adopting Yin’s advice, rigour was applied, with exactly the same methods repeated in the second iteration.

4. *Skills*: because of continuous interaction, between the issues being studied and the data being collected, case studies require experience and skill. A basic list of desired attributes which I have exercised includes: (1) asking good questions – and interpreting the answers

fairly; (2) being a good “listener” not trapped by existing ideologies or preconceptions; (3) staying adaptive, so that newly encountered situations can be seen as opportunities, not threats; (4) having a firm grasp of the issues being studied, even when in an exploratory mode; (5) conducting research ethically, from a professional standpoint but also by being sensitive to contrary evidence (Yin, 2018, p. 132).

5. *Rivals*: showing that rival or contradictory evidence to the predicted result has been considered and the stronger the rivals, the more it sheds light on the case. This was taken into consideration and provided insight into the one different perspective from amongst the group of teachers.
6. *Quality*: needs to be examined in relation to commonly used tests in social science research, particularly reflexivity and validity, as explained hereafter.

5.2.4 Reflexivity

According to Creswell (2000), being self-reflective is one of the fundamentals of qualitative interpretive research (Creswell & Miller, 2000), as every researcher brings their own voice and epistemological stance. Yin (2018) stresses reflexivity to maintain rigour, particularly in observations, and maintains that bias cannot be avoided. Creswell (2012) explains that a transcript might have several different interpretations but that does not mean that one interpretation is better or more accurate than the other or that one is more biased than the other; it simply means that researchers bring their own perspectives as they interpret the data (Creswell, 2012). Nevertheless, considering that the act of researching itself is never unbiased (Bourdieu & Wacquant, 1992 p. 39), the task of putting reflexivity to work and identifying one’s research voice is imperative in qualitative research (Creswell & Miller, 2000).

Being a practitioner with over two decades of engagement and work with teachers, my interpretations of their experience during this intervention is bound to be shaped by my previous practice, frame of mind, and epistemological stance. Through the power of reflection, I acquired skills which helped me to “experience surprise, puzzlement, or confusion” (Schon, 1987, p. 27)

in situations that were not puzzling at first and to question prior understandings and behaviour to generate new understanding of those same situations (Schon, 1987). I found myself in constant conversation with myself, similar to a “dialogue of thinking and doing” (Schon, 1987 p. 31) which helped me to experience a shift of consciousness which altered my way of thinking, seeing, and hence interpreting but also “being in the world” (Wenger, 1998 p.151).

I was more aware and conscious of recognising my own “biases, beliefs, and assumptions”, particularly those that relate to learning, technology, and society which I see intertwined in a constant relationship (Bourdieu & Wacquant, 1992 p. 40). By practising reflexivity, and challenging my taken-for-granted frames of understanding, I kept “self-questioning” my assumptions (Bourdieu & Wacquant, 1992 p.40). I was also attentive to my multiple roles – as both director of the programme and researcher – and my previous teacher experience, particularly during the intervention, as I naturally shifted to my teacher identity and lived the experience with them, feeling like one of them.

Insiders can be viewed as “members of specified groups, or occupants of specified social statuses, while outsiders are the non-members” (Merton, 1972, p. 21). As Griffith (1998) explains, “an insider is someone whose biography gives her a lived familiarity with the group being researched” while the outsider is “a researcher who does not have any intimate knowledge of the group being researched, prior to entry into the group” (p. 361). This constant back-and-forth reflexivity within my identity, the organisation I work for, and the research, created blurred boundaries between outsider and insider researcher identity. As expressed by Mercer (2007), the “insider-outsider dichotomy” appeared like a continuum with multiple dimensions, constantly moving back and forth along a number of axes, depending upon time, location, participants and topic (Mercer, 2007 p. 99).

The question that I asked myself, then, was whether this background in teaching and identification with teachers a detriment or an advantage. Simmel (in Mercer, 1950) argues that to be objective one needs to be detached from the research account (p 2.) while Merton (1972)

asserts that insiders comprehend the intricacies of a culture in a way that a non-native could not, because they have experienced the sensitivities that make empathic understanding possible (Merton, 1972; Simmel, 1950 in Mercer, 2007).

I would argue for “insiderness” as an advantageous continuum rather than one side of opposing poles. This continuum provides a more holistic view to making meaning, and a deeper interpretation of the relevant patterns of social interaction within this group, whose culture I relate to and connect with. Furthermore, being an insider enables an engagement in dialogue with teachers as they exchange perspectives around their objective, subjective, and social worlds, and to check for understanding of those interpretations. In addition, I argue that temporal distance is an advantage for insider researchers because leaving the data and stepping back enables researchers to look at the cases with a different eye when they return to them.

5.2.5 Validity

Positivists argue that “it is only through the exercise of physical or statistical control of variables, and their rigorous measurement, that science is able to produce a body of knowledge whose validity is conclusive” (Hammersley & Atkinson, 2007, p. 6). Generally, positivists validate their data based on the assumption that social facts have an objective reality with variables that are measurable and controllable, and collected by developing an explicit, standardised set of data elicitation procedures (Hammersley & Atkinson, 2007). Distancing themselves from positivist paradigms, interpretive, naturalistic researchers believe that human actions are infused by “social or cultural meanings: that is, by intentions, motives, beliefs, rules, discourses, and values” (Hammersley & Atkinson, 2007, p. 8).

The process of establishing validity methods therefore differs greatly between positivist and interpretivist research. The latter relates more to concepts of “authenticity and trustworthiness” than to “causal relationships”, standardised measures or the “subsumption of social events under universal laws” (Lincoln & Guba, 1987 p 245-251). Naturalistic, interpretive

accounts require criteria that are aligned with research grounded in understanding culture and the complexity of real-life experiences (Denzin & Lincoln, 2011, p.168). Building on the work of Lincoln and Guba (1987) to improve the usefulness of results in naturalistic approaches, I have used four criteria that they recommend to ensure validity: (a) credibility; (b) dependability; (c) conformability; and (d) transferability (Lincoln & Guba, 1987), and have explained in Appendix N how they are met in this research. Section 5.3 explains the sampling and is followed by the methods in Section 5.4.

5.3 Sampling

The school selection was purposeful to represent a faithful depiction of participants teaching in schools with a high number of refugees. In line with the aims of the research, and in close collaboration with the Ministry of Education, communication was established with the schools that had the highest percentage of refugees to gauge their interest in the intervention. The Ministry of Education advised that the intervention should benefit all children learning in public schools, Syrians and Lebanese. This made sense since secondary age Syrian students were only learning in morning-shift schools. Furthermore, it allowed them to engage with their Lebanese peers.

Following an initial phone call from the Ministry of Education Department of Orientation and Guidance (DOPS), an informative email was sent out from the IEA. It included a description of the intervention and required that (a) two teachers – of sciences and computer studies – commit to participating in all workshops; (b) schools have a space for the implementation and storage of the ICT kits; and (c) they engage Syrian refugee students in the implementation.

All schools expressed interest in participating in the programme, yet most of them faced challenges because teachers were already stretched in several training programmes. In addition, computer teachers at school were overwhelmed with daily data entry requirements to track refugees' attendance and retention rates. Principals were called to further explain the

purpose of the intervention, the benefits for teachers, the commitment needed to participate, and the obligation for participants to sign consent forms.

Four schools, where the computer teachers could not join the workshops, suggested that a maths teacher accompany the science teacher and that computer teachers would collaborate with subject teachers at school. Three schools had no computer teachers and proposed to send a maths and science teacher. In one of the schools, the humanities teacher, who also provided psychosocial support to refugees, proposed to accompany the science teacher. In addition, three principals and two school administrators requested to accompany their teacher(s) to have a better understanding of the intervention. Finally, a total of 42 educators comprising 37 teachers, three school leaders, and two administrators from 21 schools registered to participate. The schools, their location, and the percentage of refugees are shared in Table 3.

Table 3*Participating Schools*

Location	Number	Name of school	Percentage of refugees	Number of students in school
Bekaa	1	Haouch Al Oumara Public Secondary School	21%	217
	2	Bar Elias Public Secondary School	42%	321
	3	Saadnayel Public Secondary School	15%	655
	4	Wadi Al Arayish Public School	51%	149
	5	Al Huda School	35%	697
Mount Lebanon	6	Jbeil Second Public School	30%	275
	7	Yahshouh Public School	30%	147
	8	Farid Salami Public School	11%	343
	9	Haret Sakher Public School	18%	381
North	10	Saba Zreib Public Secondary School for Boys	3%	179
Beirut	11	Antelias Public School	29%	334
	12	Rafic Hariri Public Secondary School – Shoueifat	11%	742
	13	Beirut Al Alia School for Girls	28%	137
	14	Andrawos Jubran Tueini Secondary School	10%	282
	15	First Basta Public Secondary School	33%	214
	16	Zahia Kaddoura Secondary School	10%	227
South	17	Jahiliya Public School	40%	211
	18	Shheim Secondary Public School	18%	280
	19	Shheim Public School	57%	381
	20	Kfarmatta Public School	61%	59
	21	Baakline Public School	66%	289

Confirmation letters were sent to schools and consent forms were returned, duly signed by teachers, prior to starting. The face-to-face workshops started in February 2017; however, as mentioned earlier, seven schools were replaced for reasons beyond our control. Participation stabilised at the end of March 2017, and it was decided that latecomers would join the

intervention in Year 2 at the beginning of the next academic year (2017–2018). In addition, due to delays in administrative processes, two schools decided to join the Year 2 workshops. Thus, 13 schools started in Year 1 and nine in Year 2. After completing Year 1, eight schools sustained their participation in workshops and working sessions as their teachers were interested in further honing their skills.

From the pool of 21 schools, nine schools were selected for the mid- and post-implementation teacher interviews and four projects were described in Section 4.6.5. The selection was purposeful to include teachers with the highest number of refugees and those that could inform the research.

Interviews were conducted in four schools the first year and five the second year. In addition, observations were conducted consistently in (a) the same regional location, selected for proximity and (b) centrally for all common working sessions, Sharing Day, and project presentations. This is further explained in Section 5.4. In addition, after completing Year 1, one of the schools requested that all of its teachers join the intervention, and additional workshops were delivered at their school, past the completion of this research.

Table 4 reflects the sample of teachers and their year of participation.

Table 4*Teachers Participating in the Intervention, Year 1 and 2*

Location	Number	Name of school	Year 1	Year 2	Year 1 and 2	Computer	Subject
Bekaa	1	Haouch Al Oumara Public Secondary School	1			1	1
	2	Bar Elias Public Secondary School		1		1	1
	3	Saadnayel Public Secondary School	1		1	1	
	4	Wadi Al Arayish Public School	1			1	1
	5	Al Huda School	1			1	1
Mount Lebanon	6	Jbeil Second Public School	1		1		2
	7	Yahshouh Public School	1		1	1	1
	8	Farid Salami Public School		1		1	1
	9	Haret Sakher Public School		1		1	1
North	10	Saba Zreib Public Secondary School for Boys		1		1	1
Beirut	11	Antelias Public School	1		1		1
	12	Rafic Hariri Public Secondary School – Shoueifat	1			1	
	13	Beirut Al Alia School for Girls	1		1		2
	14	Andrawos Jubran Tueini Secondary School		1			2
	15	First Basta Public Secondary School		1	1		2
	16	Zahia Kaddoura Secondary School		1		1	1
South	17	Jahiliya Public School	1		1		1
	18	Shheim Secondary Public School		1		1	
	19	Shheim Public School		1		1	1
	20	Kfarmatta Public School	1		1	1	1
	21	Baakline Public School	1				2

Total	13	9	8	14	23
	13	17		14	23

5.4 Methods

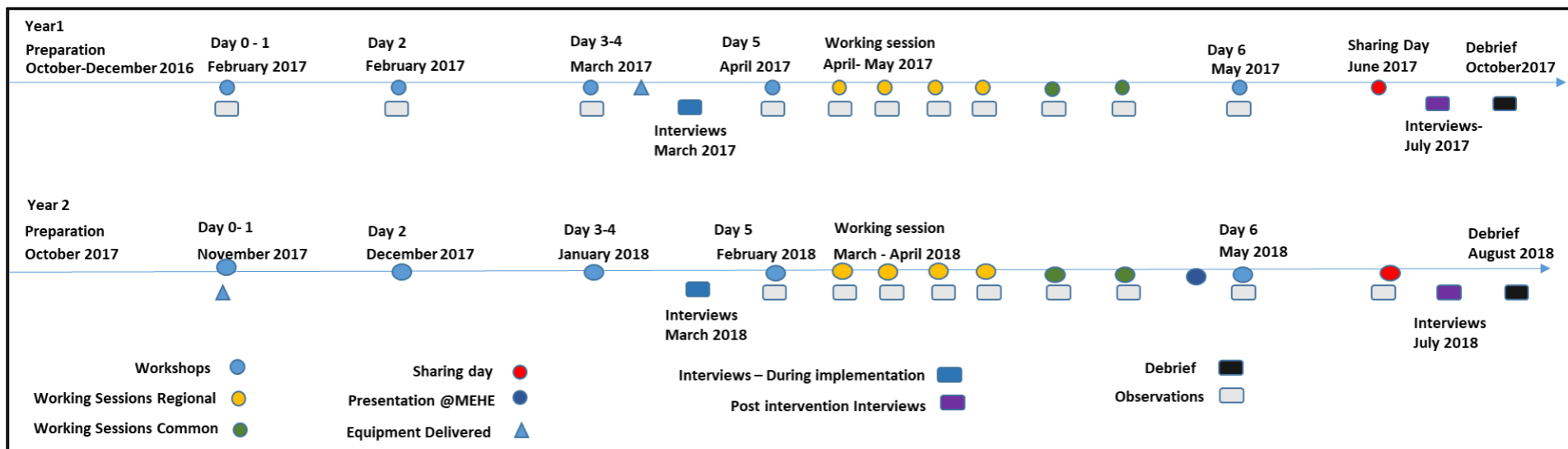
Methods should be chosen in terms of their practical value for dealing with a specific research problem (Denscombe, 2007 p. 109). The methods selected for this research are in-depth semi-structured teacher interviews, group interviews, and observations, which were chosen to enable the data to emerge from the field, with the possibility of cross-validating interpretations. This differs from research methods that run under “conditions created by the researcher – such as in experimental set-ups or in highly structured interview situations” (Creswell, 2007 p. 295). While the perspectives of all participants were considered during interviews and observations, particular attention was given to teachers who provided detailed information, to better understand their agency in practice (Creswell, 2012, p. 206). Those cases are explained following the description of the intervention in Section 4.6.5 and contrast with the perspectives of a teacher a teacher with opposing views. Additional methods – teacher questionnaires and interviews with principals, students, and parents – not included in this report, were part of the larger IDRC study as mentioned in Chapter 1. The methods and the timeline are explained following Table 5 and Figure 10.

Table 5*Methods Overview*

Type	Details	When	Year 1	Year 2	Number of interviews	Who	Number of participating teachers	Place	Data generated
Interviews									
Group interviews	Part of Day 0	Pre-implementation	1	1	2	Teachers	42	ACS	Conversation transcripts, journal
	Debrief	Post-implementation	1	1	2	Teachers	18	BDD	
Semi-structured interviews	After Day 4	During implementation	4	5	9	Individual Teachers	18	South (1) Mount Lebanon (1) Beirut (1) Bekaa (1)	Transcripts
	After completing classroom implementation	Post-implementation	4	5	9	Individual Teachers	18	South (1) Mount Lebanon (1) Beirut (2) Bekaa (1)	
Observations									
Participant observation	Workshops 1 to 6	During	6	6	12	Teachers	16	USEK	Conversation transcripts, journal, teachers' reflections
	Regional working sessions	During	4	4	8	Teachers Students	12 40	USEK	
	Common working sessions	During	2	2	4	Teachers Students	70 250	BDD	
	Sharing Event	During	1	1	2	Teachers Students	35 135	BDD	
	Presentations	Post-implementation		2	1	Teachers Students	28 70	Ministry of Education	

Figure 10

Methods Timeline Overview



5.4.1 Interviews

According to Holstein and Gubrium (2003), the interview as a means of data is a “universal” mode of systematic inquiry (p. 10) and has become a means of building a narrative, in which people divulge their accounts in response to interview inquiries. Yin asserts that well-informed interviews can provide important insights into actions and should always be corroborated with information from other sources to avoid common problems of bias, or poor or inaccurate recall (Yin, 2018, p. 185). Indeed, interviews are an essential source of evidence (Yin, 2018, p. 185), particularly when they are prolonged, such as in this case study, as they took place over the extended period covering the intervention. Two types of interviews were held, semi-structured interviews with individual teachers and group interviews. Group interviews were conducted, pre- and post-implementation and the pre-implementation was integrated in Day 0. Semi-structured interviews were conducted with the same teachers twice in their schools; the first interview was conducted after Day 4, around the time when teachers started classroom implementation, and the second was conducted after they had completed the implementation, reflected on their work, and assessed the artefacts created by students. The interviews are explained hereafter.

5.4.1.1 Semi-structured interviews. Semi-structured interviews were selected to provide space for participants to speak, and to provide open-ended guiding questions in a flexible manner. It is a process that enables the researcher to “probe” for further information, elaboration, and clarification of responses, while maintaining a “feeling of openness to the participants responses” (Holstein & Gubrium, 2003 p. 10). Denzin and Lincoln (2011) explain that,

the interview is a conversation – the art of asking questions and listening. It is not a neutral tool, for at least two people create the reality of the interview situation. In this situation, answers are given. Thus, the interview produces situated understanding grounded in specific interactional episodes. (Denzin & Lincoln, 2011, p. 645)

As mentioned in Section 5.3, the interviews took place with teachers (n=18) from nine (n=9) schools selected purposefully to inform the research. All interviews were conducted in schools, except one post-implementation interview, which was held online using Zoom meetings, because of a strike and transportation issues on that day. They are presented in Table 3.

Table 6

Distribution of Participants in the Semi-Structured Interviews

Location	Number	School Name	Computer Teacher	Subject Teacher
Bekaa	1	Bar Elias Public Secondary School	1	1
	2	Saadnayel Public Secondary School	1	1
Mount Lebanon	3	Jbeil Second Public School		2
	4	Yahshouh Public School	1	1
Beirut	5	Jubran Andrawos Tueini Public Secondary School		1
	6	Beirut Al Alia		2
	7	Antelias Public School		1
South	8	Kfarmatta Public School	1	3
	9	Baakline Public School	1	2
Total			7	13

Generally, 45 to 60 minutes were dedicated to each interview, giving ample time for participants to tell their stories. All interviews were recorded and transcribed, and after each visit, I updated my research journal. Interviews were guided by an initial question asking them about their experiences, beliefs, challenges they faced, and how they mitigated them, leaving

space for teachers to express themselves and raise new questions. The mid-intervention interviews started after Day 4, thus allowing interviewees to share their project design and explain their interpretations, beliefs, thought processes, and meanings, which were used as the basis for further inquiry. Interviews were held in the place of their choice, allowing teachers to be comfortable with the process.

In all schools, interviews started in the principal's office and continued in the classroom where they had installed the equipment and were working with students. The classroom walls were generally decorated with their community map and research mind map, which helped the conversation extend naturally to the implementation with students, the challenges faced, the motivation (or lack of) around the project, and their progress. In the post-implementation interviews, teachers shared their thoughts and perspectives on their work, their reflections about the entire TPD, and they explained the process which they had followed with students to design and create artefacts.

5.4.1.2 Group interviews. Two group interviews were conducted in each iteration. The first one – pre-implementation – was incorporated in Day 0 before starting the intervention, and the second – post-implementation – was a debrief after the implementation. Following Yin's (2018) suggestions, group interviews were considered as types of interviews to elicit intersubjectivity and reflective processes. A group interview is a method set in qualitative social research to generate collective views (Creswell, 2012). As a method, it is frequently used to help groups of teachers reflect (Greenleaf et al., 2011, p. 668). The pre-intervention took place on Day 0 and included the voice of all participating teachers. The topics in the pre-implementation focused on participants' views around pedagogy and ICT while the post-intervention focused on participants' perspectives on the experience.

All participants were invited by email and those willing and able to join participated in it. The data generated from the group interviews were recorded, yet only the post-implementation debrief was transcribed, as the first video was damaged due to a file corruption error. The group

interviews were moderated without participation in the discussion, which allowed participants to be open and honest and express their own views, rather than to expect cues as to what to say. The same format was followed in the pre- and post-implementation group interviews, whereby the topics were introduced, and participants discussed them around a table in groups of four to six, with one member from each group then presenting a summary of the points to all participants. Presentations were followed by comments and a larger group discussion.

5.4.2 Observations

Observations took place during workshops and working sessions in which teachers were allowed to bring a team of five students engaged in projects to discuss, share, and complete their work. This type of observation is referred to as “participant observation” (Yin, 2018), and is a special mode of observation in which I assumed a variety of roles within the intervention. This included participating in the morning and end-of-day feedback and reflections of teachers during the six-day workshop, having conversations with teachers about the progress of their work during working sessions, leading a session when a trainer had special circumstances, or answering participants’ questions as a decision-maker.

This type of observations as explained by Yin (2018) offers certain unusual opportunities to gain access to events or groups that are otherwise inaccessible to a study, and the ability to perceive reality from the viewpoint of someone inside a case rather than external to it. It allowed me to engage in conversations with teachers, particularly at the beginning and end of the workshop, to prompt and probe their reflective thoughts. I focused on observing the intervention in one location and systematically debriefed with trainers and volunteers. This allowed me to be consistent with the same teachers, to discuss over time their experience in a naturalistic manner, and to triangulate the data.

Observing sessions enabled me to engage in a sustained manner with teachers when they reflected at the beginning and end of every workshop. Indeed, reflective thinking and writing has been widely used in qualitative research and lies in what Denzin and Lincoln (2011)

refer to as interpretive interactionism which is the act of interpretation of the communication act with one or more people (Janesick, 1998; Denzin & Lincoln, 2011). Reflections were elicited during workshops through communicative action between teachers around their shared experience. The process seemed effective and provoked individual inner thoughts, which were discussed collectively.

All those sessions were recorded and transcribed, while final reflections were collected online using Mentimeter and on paper for those that preferred to write. This allowed for discussion and mitigation of the challenges that they faced during the implementation. Two science teachers, for example, felt confused with the emergent and open-ended aspect of the project. They reiterated the need to have a document with instructions to follow. It generated further discussions to provide guidance without reducing the open-ended emergent process, and informed the development of open-ended learning designs with teachers.

In addition, these reflective conversations contributed to including the voices of all teachers and to shed light on untapped questions. Computing teachers, for example, expressed their feelings about devices and how they engaged with ICT, and their feedback would not have been possible without regular ongoing conversations and reflections. A particular point, mentioned recurrently, was that the devices were uncluttered and open, which made it possible to explain to students the opportunity to engage with and interact with physical objects. Teachers said that it enabled students to engage with complex concepts that would otherwise have been abstract, which unveils an area that seems to be untapped within maker-space technologies. Indeed, there seems to be a missing gap in the literature around pedagogies that can foster knowledge-building using maker-space equipment.

Thus, observations were invaluable as teachers exchanged, in natural and unsolicited ways, information and insights into their inner thoughts, which had not emerged from interviews. They shared their views and explained how they implemented the project with their students.

One of them even shared the exchange of text messages between herself and the students, and explained how she was able to see the progression of their thinking.

However, the disadvantage of this natural setting was the inability to take notes and record systematically, which was mitigated by taking notes immediately after the session and by recording discussions with teachers when possible. Furthermore, since teachers knew that I was conducting research, I discussed with them my interpretation, and they gave insights into their progress and the challenges that they were facing. This generated rich data, which was corroborated with the data generated from the interviews and the feedback of the trainers in the other locations. The data generated from the observations included audio transcripts of the workshops, audio transcripts of conversations with teachers during working sessions, and my research journal.

5.5 Approach to Coding

Coding is a qualitative research process in which the researcher makes sense out of data, divides it into text or image segments, labels the segments, examines codes for overlap and redundancy, and collapses these codes into themes (Creswell, 2007). Through reading the numerous guidelines available for researchers to learn how to analyse qualitative data, one realises that there is no single, accepted approach to analysing qualitative data (Miles & Huberman, 1994). I followed an inductive bottom-up thematic coding approach, which consists of first collecting all the data and then preparing all of it for coding and analysis. As suggested by Creswell (2012), in the case of “bottom-up, interpretive data analysis” (Creswell, 2012, p. 237), I went from the “detailed data and coding descriptions within the text to the general codes and themes” (Creswell, 2012, p. 238). Although the process included six distinctive phases, it was an iterative process, which required going back and forth looking at the theme descriptions and codes, often changing and elaborating what I had previously coded to develop a deeper understanding of the data and refine the codes, which were grouped under the main categories as explained in the analytical framework. The phases I followed were as follows:

5.5.1 Phase 1: prepare and organise the data for analysis

This phase included organising the data and storing it in a way that was accessible when I needed to locate it. In line with Creswell's (2012) recommendation to back up the data, I duplicated all the audio and video recording in two places, on my computer, and in an online password protected space. The data also included a transcription of my journal with field notes taken during workshops and working sessions. Transcribing the audio and video files to text took numerous hours and represented hundreds of hours between the group interviews, the many individual interviews, and the lengthy discussions with teachers and students during workshops and working sessions. In tandem with this, I re-read all my personal field notes in my notebook and annotated them.

5.5.2 Phase 2: explore and code the data

During this phase, I read the material several times to obtain a deeper sense of it and constantly compared the data that emerged in an inductive process. I often came back to teachers with questions to ensure that I had fully grasped their meaning. At the same time, I developed an Excel worksheet in which I tabulated all the data, and kept a record of the excerpts.

I transcribed the data from the workshops, working sessions, and interviews in sequence, referenced the questions asked, marked the text to reflect signs of silence for example, and added memos on the side of the text on my field notes. Although it was very time-consuming, it made me hear things that I had not previously noticed, and I realised the value of spending time in the field. During this phase, I also organised participants' reflections. Finally, I worked on putting all the codes and annotations into an Excel worksheet with their source and number of occurrences to make the grouping of codes into themes fluid and easy to modify. Reading many times allowed me to connect categories by comparing incidents in the data to other incidents, incidents to categories, and categories to other categories.

5.5.3 Phase 3: coding to build description and themes

The more I read through the data, the more I realised that the data was very rich and provided depth for analysis. I started regrouping the themes and read the texts more critically. I let the themes emerge from the data before grouping them in the elements of the analytical framework – *Agency, Cultural Practices and Structure* – (Pachler et al., 2010). I examined the texts in depth, particularly the conversations I had had with participants and how this tallied or contradicted their reflections, actions, and feedback. I continued marking up the text, often adding to the initial codes and grouping them into themes. A theme became relevant when it was based on perspectives expressed by multiple participants. The initial themes that emerged at this phase were referred to as “Level 1”, which were then grouped to form sub-themes. When I found contradictions, I went back to the texts and often called teachers and facilitators to clarify my understanding. Once the themes and sub-themes were set, an additional level of abstraction was added within each category. The initial themes are shared in Appendix O and the organisation of themes is explained in Section 5.5.3.1.

5.5.3.1 Organisation of themes. As mentioned above, themes were organised iteratively, with a ground-up and inductive approach. After putting the first-level themes in tables, shown for reference in Appendix O, I searched for relationships in the data. This was intricate as there were numerous and varied ways to establish those relationships. The themes were reorganised, and the progression from the first to the second iteration is shown and explained in tables 7 and 8.

Table 7*Reorganised Themes*

The overarching themes	Theme	Representative theme 2 nd iteration	Representative theme 1 st iteration
Agency in Practice	Cultural practices	Beliefs and mind frames	Beliefs and mind-shifts about <ul style="list-style-type: none"> • <i>Moral value</i> • Themselves, their self-esteem, interests • Their students and their capacities • ICT • Pedagogy and real life
	Structure	TPD structure	Enhanced teaching Socioemotional <ul style="list-style-type: none"> • Collaborative relationships with peers in the TPD • Motivation, contributing to social good • <i>Moral value</i> • Sense of purpose Cognitive <ul style="list-style-type: none"> • Ability to conceptualise • Making connections between curriculum and knowledge in the world • Real-life problem-solving • Technological skills
		School structure	<ul style="list-style-type: none"> • Relationships around learning during the implementation • Improved communication • Reciprocity • Enhanced learning • Community connections • Cohesion
		Challenges	At School and in the TPD Time to learn and implement Curriculum and exams <ul style="list-style-type: none"> • Modelling • Open-endedness • Bureaucracy

At first, the representative themes were grouped around *cultural practices*, *structure of the TPD*, *school structure*, and *challenges*. The themes, *teachers' beliefs*, and *mind-shift* grouped the transformed perspectives of teachers, how they viewed themselves, their students, Syrians and Lebanese and their capacities, their usage of ICT and views about their

affordances, and pedagogy. The TPD structure grouped the themes which resulted from their description of their experience in the TPD under the main heading, enhanced teaching with two sub-headings, grouping *socioemotional* and *cognitive* themes. The *socioemotional* grouped the relational aspects during the collaborative experience and the *cognitive* grouped themes that reflected the knowledge they gained to design their project. *School structure* grouped the themes that emerged during implementation, and *challenges* grouped challenges faced while learning in the TPD and to implement at school.

The process was iterated several times and continued to be inductive starting from the data. In the first iteration, a *sense of purpose* and *moral value* were considered to be part of the *socioemotional* themes generated by the TPD. Through the conversation with teachers, *moral value* as a theme was placed under *cultural practices*, as it seemed to underpin their *beliefs* and *mind-shifts* around social good, while *sense of purpose* was explained by participants as their own sense of purpose, which was provoked during the experience. The term *mind frame* was utilised, rather than mind-shift (mind frame), to include the opposing case which persisted in the same mind frame and did not adapt to new ways of thinking or doing.

In addition, the *relational* aspect appeared across the data, as teachers described their learning experience in the TPD and during implementation which started in the classroom and extended after school in the community. Thus, a final organisation took place as shown in Table 8. It grouped elements of structure with *TPD*, *school* and *community* to include the extension of learning out of school during the implementation, and the knowledge and skills teachers gained under socioemotional and cognitive themes.

Table 8*Themes Organised*

The overarching themes	Theme	Representative theme
Agency in practice	Cultural practices	Beliefs and mind-shifts <ul style="list-style-type: none"> • Moral value • Self • Students' adaptation and capacities • ICT and their affordances • Pedagogy and its real-life aspect
	Structure	TPD, school, and community <ul style="list-style-type: none"> • Enhanced teaching • Inter–intra relationships • Socioemotional and cognitive gains • Time to learn and implement • Curriculum and exams • Cohesion • Bureaucracy

Once the themes were reorganised, a final step took place with an abstraction of the themes, briefly explained hereafter, and presented in Table 9.

Cultural practices grouped beliefs and mind frames. This level of abstraction included the *moral value*, which teachers considered as a main driving force in the process, *teacher identity* which underpinned how teachers expressed their renewed self, *capacities* which expressed how they viewed their students' capacities, and *stereotypes* (their changing sociocultural beliefs), *ICT affordances*, and *emergent pedagogy*. In addition, the term *emergent* was utilised, rather than real-life pedagogy.

Structure encompassed the themes that support teachers' experience in the *TPD* and the *school* implementation that extended into the *community*. A level of abstraction included teachers' *professional growth*, *control*, and all the *relationships* around learning with others in the TPD, at school, and in the community. It covers the role of collaboration and the conversations around the shared experience, which gradually took them from experimentation

to conceptualisation, to mitigating challenges. Although those relationships started in the TPD, they impacted the relationships around learning at school and in the community. Thus, that level of abstraction was grouped under *TPD, school, and community*. It is important to emphasise that although these themes were grouped in a table, there were many intersection areas, as will be explained in the findings.

Table 9

Abstraction of Themes

Overarching theme	Themes	Level of abstraction
Agency in practice	Cultural practice	Epistemological beliefs and mind frames <ul style="list-style-type: none"> • Moral value • Teachers' identity • Capacities • Stereotypes • ICT affordances • Emergent pedagogy
	Structure	Teacher professional development, school, and community <ul style="list-style-type: none"> • Professional growth • Relationships • Control • Bureaucracy

5.5.4 Phase 4: report qualitative findings

During this phase, I reviewed again the themes by going back to the transcripts, the excerpts, my notes, and participants' reflections, reading through the lines, the transcriptions of interviews, and my field notes. I selected from teachers' narrative texts to include in the findings.

5.5.5 Phase 5: interpret findings

During this phase, I shared the findings with the team at IEA and discussed my interpretation with participants, making connections between the themes. At this point, I went

back to the overall aim of the research and checked for new initiatives in the field of teacher education and teaching and learning in refugee contexts, adding my personal views and suggesting the limitations of the research.

5.5.6 Phase 6: *validate the accuracy of the findings*

During this phase, I checked the accuracy of the research with the teachers who expressed interest in discussing the research findings. Generally, participants preferred to receive a summary of the findings rather than the full document and these back-and-forth discussions gave me the opportunity to validate the findings and have even deeper conversations with participants. In Section 5.7, I explain how I dealt with ethical considerations and the limitations of the research.

5.7 Ethical Considerations

I confirm that I abided by rigorous ethical considerations in compliance with the updated British Ethical Research Association Ethical Guidelines (BERA, 2011) and took measures that are essential to avoid potential abuse or harm to participants, since the teachers that participated in the intervention serve a vulnerable population. To address these considerations, at the onset of the research, I proposed the following:

5.7.1 *Values of Respect, Trust, and Integrity*

A key element of interpretivist thought is the demand that the social researcher should adopt an attitude of respect or appreciation towards the social world (Creswell, 2012). Respect, trust, and integrity were established at the onset of the research and transpired through the intervention planning, implementation, data collection, and analysis, be it with trainers and volunteers or with teachers. Internal rules of conduct that promote such values were shared with the team at IEA during the preparation phase, with a stress on respect. To gain and establish trust of participants and engage them in the research process, I was explicit and transparent from the start about the exploratory mode of the research, why their opinion mattered, and how they were contributing to my research.

In addition, I established a good rapport with teachers and ensured that they knew that there was no hidden agenda. Teachers signed consent forms before participating in the implementation. Participants' consent forms are shown in Appendix P. Teachers were asked for permission for interviews to be recorded. Participating teachers were told that they could withdraw themselves from the programme or research at any point.

5.7.2 Confidentiality and Anonymity

Participating teachers' names throughout all interviews, discussions, and observations were anonymised and anything shared in confidence by a participant who preferred that the information was not quoted is not included in the research. Field notes and data remained confidential and discussed with my advisor. All media and pictures taken during the interventions were shared with teachers and stored on a password-protected page on the IEA site. Participants were also welcome to share their own pictures on the IEA platform and have the option to enable or disable sharing the information with others or keep it private.

5.7.3 Data Storage and Security

The raw data generated during the research, including the interviews and reflections, were stored with a back-up in a password-protected area. My journal and field notes were kept confidential.

5.8 Report and Dissemination

As mentioned in Section 1.3, the IDRC funded the research and thus a technical report about the wider research was generated and made available online on the IDRC Research Connect platform (<https://www.idrc.ca/en/funding/resources-idrc-grantees/idrc-connect>). An external evaluation (Tawil, 2018) was conducted and IDRC disseminated the findings at conferences around refugee education. The research was also highlighted in a synthesis of 44 international IDRC research projects conducted between 2016 and 2018 (Hagerman & Hagerman, 2018) and in the IDRC Annual Report 2018–2019 (IDRC 2019).

5.9 Researchers' Journal

As a researcher, I kept a journal which I updated at the end of each workshop, working session, and throughout the interview process. In addition, I organised the audiotapes of workshops, working sessions, interviews, debrief sessions, and group interviews. Participants were asked if they were at ease with this before the start of sessions. In all instances, everyone agreed and the recorder was placed on a table at the start of the session and turned off at the end. Pictures were taken by participants and were shared by themselves during the workshops and working sessions. In addition, a final presentation at the Ministry of Education was videotaped with permission from participants. Even though the pictures and videotapes were not intentionally taken to contribute to the methods, they arguably contributed to informing the data and therefore, in some instances, helped to cross-validate or contradict data generated from the interviews and the journals. It also helped me to understand more deeply the changes in teachers' perceptions and how they felt throughout the intervention through their body language, smiles, and engagement. My notes were handwritten in a notebook and included the description of the interventions, the working sessions, and the feedback from facilitators and volunteers who supported the working sessions technically. My journal also included my first impressions and the questions that puzzled me in the process. In conclusion, I confirm that I bear full responsibility for the data collection and analysis.

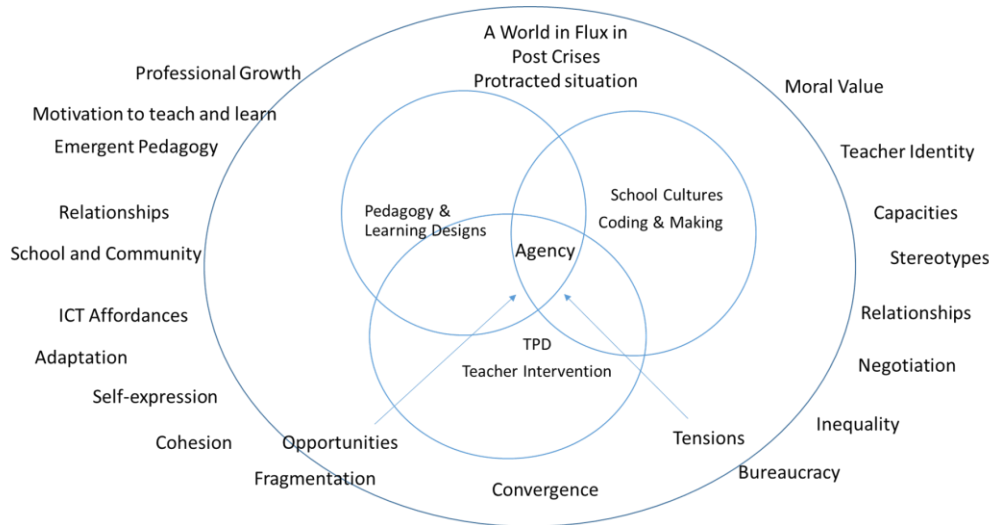
6 Findings and Discussion

6.1 Findings

The findings are presented according to the themes that emerged, and refer to excerpts from the data. The themes are (1) teachers' professional growth; (2) the emergent pedagogy; (3) ICT affordances; (4) moral value; (5) teachers' identity; (6) capacities; (7) stereotypes; (8) control and accountability; (9) relationships; and (10) bureaucracy. They are intertwined as explained in the analytical framework and presented in Figure 11, referencing Turvey and Pachler's (2016) "problem spaces" (see Section 2.8). A discussion on the themes then follows.

Figure 11

Findings Using Turvey and Pachler's (2016) "Problem Spaces of Technology-Enhanced Learning"

**6.1.1 Professional Growth**

The TPD teacher intervention appeared to provide the structure for teachers to grow professionally. During the group interviews, teachers (n=17) mentioned that collaboration with their colleagues from the same school and across schools helped them on several levels, giving them more confidence to engage wholeheartedly in the experience. It helped them to feel more confident because everyone struggled, felt “uncertain”, and the project “took them out of their comfort zone”. Teachers (n=18) with no experience with open-ended pedagogy, as well as those with no previous experience with the ICT used in the intervention, engaged in the process. They viewed themselves as learners, exchanged perspectives, and designed open-ended projects. They were motivated to learn and teach and (n=18) gained pedagogical and technological skills which they put into practice. They were able to engage Syrian and Lebanese students, in collaborative problem-solving, designing a solution, and creative productions and expression. They gained skills such as reflection and metacognition, which they had otherwise found difficult to implement with students.

All teachers found that the benefits gained far exceeded the challenges. They compared their growth to solving a puzzle and discovering the picture when the pieces started fitting together. They (n=2) reiterated the importance of having instructions to follow. All of them (n=18) estimated that they needed (a) more time to learn and practise the pedagogical process, and (b) more confidence and deeper knowledge of Python and Scratch. Generally, they appreciated being more conscious of people and the world around them. Finally, they appreciated being given the opportunity to continue learning. Here are excerpts of what they said in the post-implementation interviews and debrief:

We have all done projects before but here it was difficult, but we are surprised as how we came up with so many ideas. It is stronger to learn with others this way; alone, we could not have done it. One idea brought another, and we designed a project. The programme interconnects everything, starting from real life, from what matters, and putting things together in this way from what we experience makes it all stronger, not only in a disciplinary way. It is a new approach. (Post-intervention group interview, Manal).

Collaboration happened in the workshops, working sessions, at school, and through the forums:

The working sessions were very helpful, collaborating helped us to think about the same problem from so many different angles. We could not have done it individually. (Post-intervention group interview, Ali)

We collaborated through the WhatsApp group. It was very helpful, there was always someone who answered my questions. (Post-intervention group interview, Amira)

We also used forums [RPi and others] for questions and people answered us because often the computer teacher did not know all the answers; this helped them to explain their problem better, it is different from having ready-made responses. They had to explain their problem ... I asked the ICT teacher and she helped me when she could. (Post-intervention group interview, Nada)

Experiencing a step-by-step approach helped us to learn and apply gradually till we could do more and suddenly, I could see the picture of the puzzle. (Post-intervention debrief, Hiba)

We gained a new pedagogical approach. We have gained new skills, critical thinking skills, solving real-life problems, computational thinking creativity and we are using technology. (Teacher debrief, Manal)

The project was exciting for us ... we were motivated to learn and want to continue learning. We still need support and won't be able to do it again without help. (Post-intervention debrief, Karim)

What I noticed in this project, is that they [students] were able to write and explain their project like adults. Before, they were only writing results and could not explain it in the way they did in this project. (Post-intervention debrief, Hala)

I am a learner too ... I have learnt to open space for conversations, for communication, for listening. I have seen aspects of my students I did not know. We have discussed the project idea and I have followed their thinking progression ... By working on this, they [students] are motivated to work more generally in class – they are more interested and take their work seriously. ... I was able to do things that were difficult. ... Before, I had difficulty to have students reflect on their learning. Here, they are reflecting and are able to apply metacognitive skills ... (Post-intervention interview, Fatima)

What I am most proud of is that I managed to complete the project even if it is not a successful one, we applied a scientific process and students learnt so much more and better ... I learnt to give them space to learn. (Post-intervention interview, Rima)

We have learnt so much in this process, as teachers and as individual, our final projects are maybe not perfect, but it is what we learnt from them that counts. (Post-intervention group interview, Nada)

The most important thing is that students learnt to think, it is really more about thinking than technology. Before, we only thought of solving problems from our books which means students were also used to solving problems from the book; but this time they are working on a real-life problem which can have so many answers. (Post-intervention debrief, Amira)

6.1.2 Emergent Pedagogy

The emergent open-ended pedagogy appeared to be challenging yet motivating, and an opportunity to create a context for learning with world relevance. They referred to the pedagogy as integrated in “*real life*” and expressed their changing mind frames in various ways, explained hereafter.

Mainly, the pedagogy contradicted their cultural practices, their habitus, and systems of thinking, their beliefs, and the principles they applied in practice. Activities such as “self and community” appeared as a point of tension as they had never grappled with such concepts, nor engaged learners in self-expressions or negotiating questions around observations or learning. During project work, they (n=4) expressed being worried if the project failed or if they could not find a solution to the problem. It also contradicted how they expected to learn – having a model with instructions to follow. Those tensions surfaced once they had completed the research phase and needed to transition to the design phase.

Consistently and recurrently, teachers reported feeling “*uncertain*” (n=16) and “*anxious*” (n=3) because the project “*took them out of their comfort zone*” (n=3); it was “*real life, there is no right-wrong answer*” (n=16), we “*had to let go*” (n=9) to engage learners in identifying a problem and solving it with “*ICT they don’t know enough*” (n=16). All of them, except the opposing teacher, could make connections with learning goals, which arguably enabled them to reflect on their beliefs about pedagogy. Here are excerpts of what teachers said about the pedagogy, their feeling of being anxious, and their changing mind frames. In the debrief, they

unanimously deemed that the pedagogy with its real-life emergent aspect was the strength of the intervention but was challenging:

At first, I did not think that the activity about self and the community was important but when I implemented them in class, I was able to understand their value and reflect deeper when I observed my students ... Asking students' interest and passion, I realised how important it is and how little I knew my students; one of my students hated herself. ... late in the project ... she said, "Now, I know what I like and what I am good at". Another student of mine was a dreamer and not really invested in his learning, now he is excited about what his learning and says he knows what he will study. The community [question] is hard and they decided that is the school because it is something that they have in common. (Post-intervention interview, Fatima)

It really is not only about coding or the RPI, we gained a new pedagogical approach ... It [the pedagogy] interconnects all disciplines, there is maths, science, language. It is stronger to teach them this way than each one alone. It enhances all the disciplines together, it is more than just maths or IT, or coding, or science or language. Putting them together in real life this way makes it all stronger. (Post-intervention debrief, Hala)

We are not doing an experiment or problem from the book, we are doing something real – it made us think differently, it is like a puzzle. One idea generated another. They were not all correct, but we were able to engage students in thinking and reflecting. (Post- intervention debrief, Manal)

In the conversations during working sessions, teachers expressed their stress and their need to have step-by-step instructions. They said,

When I learn, I need to have instructions. It makes it easier for me to follow and continue learning. (Common working sessions, Fatima)

I am starting to stress and recently, I am not sleeping well. I wake up in the middle

of the night worried. We have done everything but are not able to find a solution.

(Common working session, Amira)

In the post-intervention interview, she explained that the process enabled her to engage students in understanding concepts and she was able to cope when she realised that failing an experiment or not finding a solution were also results. In other words, it is the learning that counts not only creating a prototype. She said,

Last time, you reminded me that this is about science and if we don't find a solution, it is also a result. I have stopped stressing so much. What is important is for students to be able to explain what they did and were able to achieve. ... They have engaged with physics concepts that are abstract, in problem-solving, questioning, and theory themselves ... I never thought I would be able to guide them [my students] ... We were working on a problem that is hidden in society. We thought that we should prevent it before it happens ... We asked experts, studied sensors and ultrasonic waves and met with a professor in Sweden. He said it was too difficult for the level of my students.

The teacher led the students to conduct research and create a prototype.

It [the sketches] helped me to map the ideas and to return to the research phase but also doing multiple sketches around their assumptions and theories. Then, I realised that their understanding of how waves travel was wrong from how they drew them. So, we went back to the concepts and asked: "How do ultrasound wave travel?" and later asked "How do they detect motion?" before hypothesising what if situations ... After that, they had several sketches which helped them to articulate what if situation ... But it is while discussing the sketches during working sessions with volunteers and facilitators that we found the solution and were able to design the model and test the assumptions. At the end, the solution turned to be simple but the process of getting there was difficult. (Post-intervention interview, Amira)

In the post-intervention interview, Fatima explained that her experience changed her views about failure:

My students learnt most when their project failed, when you asked us questions that we could not answer. All of a sudden, it was real, not something in their heads. This is a different way of thinking of success and failure... I have also realised that my students are able to explain their ideas clearly, not only in writing, but explain them to other people. (Post-intervention interview, Fatima)

Reflecting after her students presented their project, a teacher explained how the process contradicts her traditional way of teaching:

The process completely contradicts the way we teach our students concerning understanding and the skills required to master competencies. Now, I perceive things differently. We feel safe to abide by Bloom's Taxonomy; we explain and start with knowledge then comprehension and complete the steps to reach the step of synthesis and problem-solving. This programme reverses all our prior knowledge, they start to think to comprehend. (Post-intervention reflection, Nada)

Such findings show teachers' epistemological beliefs and mind frames and suggest that if teachers learn a different way of approaching learning, it may contribute to bridging the gap between old anchored beliefs and shaping beliefs based on practice.

6.1.3 ICT Affordances

At first, teachers (n=18) thought the project was only about ICT and were excited by its cutting-edge aspect. However, when they explored ICT affordances, and engaged in planning project learning goals, they gradually shifted their mind frames about ICT as a motivational element. Furthermore, explaining to teachers the affordances of ICT enabled them to select ICTs before starting to tinker. All teachers mentioned that they needed more time to learn and practise with Python, Scratch, and the electronic sensors and motors. However, despite the little knowledge they had, they did not find it difficult to use ICT in project work with students.

Teachers mentioned a special relationship to ICT because it was uncomplicated, open, and enabled a physical engagement. This special relationship was not similar for all teachers. Science teachers said that manipulating sensors and motors enabled students to engage with complex and abstract concepts, while ICT teachers found that the openness of the technology was particularly appealing to them and to students. Thus, the fact that students could physically manipulate the ICT seemed to demystify computing as a big black box.

However, one computer teacher (n=1) did not seem at ease with dealing with circuitry, and sensors and motors, and preferred to learn software than to engage in physical computing. In addition, all teachers used ICT to communicate, exchange ideas, and help each other, relying on complementary skills. With some exceptions, teachers of science relied on ICT teachers and vice versa. At first, they underestimated the integrated pedagogical and technological approach and were driven by the technological aspect. The experience helped them to realise that the intervention was not about ICT, but used ICT. They reported that the integrated process strengthened their understanding of the pedagogy and the ICT more deeply than if each one was taught alone, and the approach impacted their ways of teaching and thinking. This is reflected in the following statements:

At first, we thought that the project was about ICT, RPi and sensors but now we know that it is about the idea, the learning and how we can use and combine them to reach a solution. (Post-intervention debrief, Fatima)

It is very motivating for me to see the result on my teaching when my students are engaged. It is not the technology, it is the curiosity in the approach. (Teacher, workshop day 5, Fatima)

In some ways, they had not imagined that a computer could be so small – when they think of computing, they relate it to a big box, but they don't know what there is in it; when they knew that it was an open-source device, it seemed to trigger their

imagination, they said ... so anyone can use it, copy it or create things with it. (Post-intervention debrief, Ali)

The students were excited about the ICT, not only because it was new but because it was open, and they could manipulate the tools. (Post-intervention debrief Karim)

As opposed to the group who learnt ICT as they progressed, the opposing teacher practised at home and waited to be more confident before introducing it to students.

6.1.4 Moral Value

The moral value of designing learning to improve one's community appeared like the glue binding the intervention elements together. Teachers mentioned being more aware and conscious of things that they had not noticed before and felt that their work was valuable. It seemed to be the impetus that made them persevere when things got difficult and was unanimously mentioned by all teachers (n=18) across interviews, during conversations with teachers, observations, reflective feedback, and debriefs. The following is an excerpt which reflects how teachers expressed the importance of the moral value during the post-intervention debrief discussion:

We felt that we were doing something valuable to others which helped us persevere when things were challenging, students cared most to do something to help the community, every time things went wrong, we got back to this. (Post-intervention debrief, Hala)

We started seeing things and aspects which we didn't before. (Post-intervention debrief, Manal)

6.1.5 Teachers' Identity

At the end of the intervention, teachers (n=18) mentioned seeing themselves with new eyes, being more open-minded and motivated, and gaining self-esteem. In the post-implementation interviews and debrief, they mentioned that it was a "*renewal process*" (n=4), a space of identity, which they referred to as "*self-discovery*" (n=4), "*thinking in new ways*" (n=18)

which motivated them to learn and teach. While all of them mentioned feeling new, Ali, Amira, and Fatima explained it in their post-intervention interviews. They said,

I feel I am someone more than just a teacher. When I walk at school, teachers come and talk to me ... I have been a teacher for 12 years; I have found myself in this programme. I am dreaming again and am passionate about teaching. (Post-intervention interview, Ali)

Amira explained her feeling of being reborn as enriching,

I am born again, it is like I see things I did not before, about what we can do as teachers ... I have learnt to think in new ways and to see things from so many different perspectives. (Post-intervention interview, Amira)

Fatima explained it as a shift in thinking. She said,

I feel renewed ... This is really different ... it is like someone who turns, turns, turns, then stops, they feel dizzy, dizzy, dizzy ... I have this feeling, I feel renewed. It has impacted me deeply. I am still processing this experience. It is a shift in thinking; there is so much more I can and will do as a teacher. (Post-intervention interview, Fatima)

Those statements reflect a profound transformation in how teachers viewed themselves, considering what they previously believed, doing and thinking in the present, and how they projected themselves in the future. It reflects their ability to try out new strategies and the amazing feeling that they were starting to teach again. This temporal dimension, exhibited by science and computer teachers, to reflect on past and present beliefs and imagine the future expresses how they manifested their transformation from passive to active agents.

6.1.6 Capacities

Teachers realised that they had false beliefs anchored in many years of teaching in public schools. This applied uniformly to all students – Syrians and Lebanese. At the start of the intervention, teachers doubted their students' capacities to adapt to this culture of learning. During the pre-intervention group interview, they found that the intervention was too complicated

for their students (n=40). Their comments show how surprised they were to find out that students were capable and interested to engage in such learning. In the debrief sessions, all teachers (n=17) except the opposing teacher, mentioned being surprised with students' ability to learn, do, and think, and their interest, perseverance, and sense of responsibility towards their work. This is reflected in the following excerpts from teachers. During the pre-intervention group interview, teachers said,

What you are proposing is too difficult for our students ... but we will try because we will get support. (Pre-intervention group interview discussion)

During group reflections (Day 3), teachers said,

I was really surprised to find that students can and are able to do the activities proposed. (Workshop reflection Day 3, Hala)

I didn't think they [my students] would be able to use the RPi or to find problems...

By working on this, they are motivated to work more generally in class – they are more interested and take their work seriously. They are more responsible and perseverant; here, I have seen aspects of my students I did not know. (Post-intervention interview, Fatima)

The opposing teacher said, however,

This is too difficult for students because the level in public school is low. Students lack motivation and self-esteem. (Interview during the implementation at the start of Day 4, Hoda)

6.1.7 Stereotypes

At the start of the intervention, teachers seem to doubt that Syrian and Lebanese students could collaborate, particularly around the community aspect. At the end of the intervention, their reflections included statements about those stereotypes. For example, Amira said,

Who says Syrian and Lebanese students can't learn together? Or that public

students can't or that refugees can't think and be responsible? (Reflections of Amira)

Teachers realised that they had false beliefs anchored in sociocultural stereotypes. The shift was gradual, as they progressed through the intervention. The case of Ali, the computer teacher who shared the transformative impact of engaging Samir in the process, was a striking example of students continuing their project work in the home of their Lebanese peers. Those shifts of mind frames applied to all teachers except the opposing teacher, who insisted that public school students were from a lower socioeconomic status, afflicted with family problems, which demotivated them from engaging, individually or collaboratively, in such learning.

Similarly, teachers were surprised by students' community engagement and parents' (n=17) enquiries about their children's improved behaviour and attitude towards learning. Except for Hoda, who had the opposite view, teachers shared, with variations, students' improved behaviour and motivation to learn. Hoda explained that she personally benefited and was proud that she could engage in the process. However, she did not believe that students in public schools or refugees could think around a real-life problem with ICT, as in addition to their low socioeconomic background, the "quality of learning [in public schools] was low, and they [students] had poor scientific knowledge and had no computers at home". She feared that students in public schools lacked motivation and interest, and would not continue the project. Her agency in practice was different from that of the larger group of teachers; that is, in observations, she was very motivated and explained the project, while students were silent. In the other groups, teachers were listening while students were asking questions and working actively on their project.

6.1.8 Control

Teachers (n=18) were bound by their curriculum and exams which seemed incongruent with the open-ended pedagogy. They were asked to engage students in learning, to negotiate community problems, and discuss the rubrics which would be used to assess their work. This contrasts with hierarchical classroom communication – teachers tell students what to do – and how they generally perceived their professional roles of controlling and assessing learning. In the intervention, they sought for support and external validation to ensure that they were on the right track. Fatima explained it as a habit – “controlling and telling students what to do” – even in project work. In the pre-intervention group interview, all teachers (n=42) emphasised their accountability to have students pass school exams:

We are still teaching a curriculum set in 1998, but what are students learning? We are doing what we used to do, but things have changed, students have changed, society has changed, and our curriculum is focused on rote learning and memorisation and our students have to pass their exam. (Pre-intervention group interview)

In one of the common working sessions, Fatima mentioned how, despite her experience in project work, she still needed to control students and the open-ended pedagogy enabled her to let go:

Before I needed to control and tell students what to do in projects, I have learnt to open space for conversations, for communication, for listening. I have seen aspects of my students I did not know. We have discussed the project idea and I have followed their thinking progression. When our project failed, I was worried that they would be disappointed, but they were not ... They create a poster on how they learnt from their mistakes, so we made a booth at school, and we explained what we did. I am asking myself so many questions, how I can do things in a new way now that the project is finished. (Working session, Fatima)

All teachers (n=17) mentioned that their students were better learners, a few (n=4) of them referred to students passing their subjects such as Ali, Fatima, and Amira. In the post-intervention debrief, teachers said,

Students are better learners; they are more perseverant and explain their reasoning.

They are more responsible towards their work and their project. They look at things from different perspectives, asking themselves what is best? They make judgements according to criteria. They look at things from multiple angles, question themselves, etc. ... before they would just take things at face value because they have to study them.

(Post-intervention debrief, Karim)

Those statements reflect the tensions between school structures and systems of thinking that teachers dealt with during school implementation.

6.1.9 Relationships

The intervention appeared to have a profound impact on relationships around learning. Teachers (n=3) mentioned that their students had difficulty at first in expressing their interests and passions. During working sessions, Fatima explained the change in a student who, “hated herself and could not find anything she was interested in”. The collaborative journey transformed her perception about herself and mid-way, during the intervention, she told Fatima she knew what interested her and what she was good at. Teachers (n=17) got to know their students, who felt better about themselves and their goals.

In addition, teachers were also worried about their students’ ability to adapt to a culture of learning that required reciprocity in relationships, particularly because of the unpredictable behaviour and violence of Syrian refugees and their fear of authority and corporal punishment. During the post-intervention debrief, teachers mentioned (n=18) that they had acquired a new way of dealing with peers, students, and leadership, and that conversations had generally improved at school for all students. They were trusted and respected by their principals. Teachers were more attentive to their students, who became more respectful and better

listeners. Except for the opposing teacher, they (n=17) described excitement at school around project work, which attracted even those not involved in it. Teachers (n=17) spoke about improved overall group dynamics (n=17), trust, and interestingly, no one mentioned violence. Arguably, when teachers invited students to negotiate learning, they learnt to listen to students and to establish a new way of communicating which extended to students and to those involved in the project, at school and in the community. Such relationships contrast with the violent behaviour mentioned in the pre-intervention-focused group. Following are excerpts from the pre- and post-intervention debriefs and interviews. The pre-intervention group interview is reported without naming teachers. In the pre-intervention group interview, teachers said,

Even the games they play are violent ... They get angry very quickly and the violence is not in proportion with the reason. A boy, for example, beat his sister really hard just because she had a better grade than him in math. (Pre-intervention group interviews)

They explained their inability to deal with the situation as it generated violence from parents towards children. They said,

It is a problem when we call parents and speak about their children, the minute we reprimand a child, they hit them in front of everyone, they hit them hard, very hard, often several slaps. (Pre-intervention group interview)

In the post-intervention debrief, one of the teachers said,

It is a new way of dealing with teaching with technology, but for me it is a new way of dealing all together, the teacher, the students and the principal. (Post-intervention debrief, Hala)

We learnt to listen to each other [teacher and students] and students got to learn to listen and value the opinion of others ... They [students] communicate differently, it is better, there is more respect and relationships have improved ... The conversation has changed ... all conversations, with me, between them and even with the principal. They

listen more, they wait, ask and think responsively. Many of them were “*mouchaghbeen*”, i.e. hooligans. Now, they all work intensively. (Post-intervention interview teacher, Fatima)

The project changed the way we communicate, together in class but also outside with other teachers and even with the principal ... The principal created a Facebook page about the project and the whole team is very proud of their work. (Post-intervention interview, Ali)

Those open and nurturing relationships around learning contrast with the current hierarchical communication system.

6.1.10 Bureaucracy

The intervention took place within extremely rigid and highly bureaucratic school structures, in a context that is fragile, with fluctuating policies for Syrians learning with their peers in the morning or afternoon shifts. In the debrief, all teachers except the opposing teacher, mentioned that the school seemed as one, and explained how the dynamics around learning extended to everyone involved, from the doorkeeper to the principal and the community. The enhanced relationship seemed to influence the school culture, from a rigid bureaucracy to a vibrant community around project work. It contrasted with the amount of paperwork that needed to be signed by MEHE officials for approval. This applied to anything and everything, such as engaging afternoon children, opening after hours, allowing teams to join working sessions, or even the Sharing Day. At the start of the project, teachers mentioned the challenge of time, school schedules, staying after school, and engaging refugees with Lebanese in the community. They had also mentioned the differing policy between the morning and afternoon shifts, the abridged school year, curriculum, and day.

Yet they were able to circumvent some of those challenges with the support of leadership. When needed, schools stayed open, and in one case even engaged afternoon shift students to participate in the project. These kinds of decisions take considerable time to be

approved by the Ministry of Education. In some cases, when documentation was missing, they took it upon themselves to start while waiting for documents to arrive. In one instance, a partner organisation could not host a regional working session and one of the schools opened its doors to trainers, volunteers, and the schools in the region, while normally this would require weeks of preparation. Thus, teachers' agentic steps were supported by leadership who encouraged teachers and teams as they progressed in the implementation.

6.2 Discussion

The research explored what learning was fostered when Lebanese teachers engaged in a low-cost, problem-orientated, technology-enhanced learning intervention with refugee children with the aim of understanding what drives teacher agency in challenging contexts. Agency in practice is intertwined with the elements of structure and cultural practices and is discussed in answering the posed research question and sub-questions:

1. What are teachers' perspectives on the learning intervention and how does it relate to their practices?
2. How are teachers experiencing this learning intervention, what is working or not, what tensions are they experiencing, and how are they mitigating them?
3. What was the process like for students to think and create their artefacts and how does it relate to their learning?
4. What value do the artefacts represent to the students, teachers, and principals?

6.2.1 What are teachers' perspectives on the learning intervention, how does it relate to their practices?

Teachers' perspectives on the intervention as it relates to their practices are presented in three paragraphs: their *professional growth*, the *pedagogy*, and *ICT* utilised in the intervention.

6.2.1.1 Professional Growth. Teachers (n=18) found the TPD experience *motivating* and *enriching*, which contradicts the tradition of disinterest and disengagement of Lebanese

teachers in TPD (Bahou, 2012). Teachers (n=18) viewed themselves as *learners*, who grew professionally and gained pedagogical (n=17) and technological (n=18) skills. All of them, except the opposing teacher, found that the intervention helped them to enhance learning, and contributed to improving *students' behaviour* and *attitude* towards learning. They (n=4) estimated that the intervention reinforced their own sense of *identity*, which they referred to as “*self-discovery*” (n=4), “*thinking in new ways*” (n=18) with a renewed energy to teach.

Arguably, except for the opposing teacher, they found the intervention *transformative*, as they (n=17) became aware of previously anchored beliefs and sociocultural stereotypes, acquired over many years of teaching in public schools. As they (n=17) became aware of students' capacities and collaborative abilities – both Syrians and Lebanese – they perceived themselves as actors who could and would do so much more in the future. It could be debated that those benefits for teachers were far beyond learning how to design a project.

The intervention showed a deep impact on how they (n=17) perceived and enacted their *professional* roles, the *moral value* driving their work, and the responsibility they showed towards students learning. All teachers (n=17) found that the intervention enabled them to gain pedagogical and technological (ICT) skills, while the opposing teacher only mentioned technological skills and the ability to construct artefacts.

Similar to ecological perspectives, teachers' professional growth could be viewed as non-linear with multiple intersecting variables and relationships between the skills collaboratively gained and their multiple usage in their day-to-day teaching (Daly et al., 2020, p. 656). Those included *enhanced professional relationships* (n=17), with peers and leadership, and transformed dynamics around learning as teachers (n=17) got to know their students, socialised their project ideas, and followed (n=4) their thinking and learning. Thus, relationships around learning became more open and reciprocal, increasing their motivation to teach and learn, making connections at school and beyond. Except for the opposing teacher – it could be contended that there was an increase in teachers' *social and emotional capital* with multiple

connections made (with peers, principals, students) around learning.

6.2.1.2 Pedagogy. Teachers' perspectives on the pedagogy utilised in the intervention were ambivalent. It appeared as a tension and opportunity that converged towards transformative practice. They (n=18) found the aspect of *emergence* motivating, yet it contradicted their systems of beliefs and practices because it was anchored in the "*real world*" as expressed in the debrief. Repeatedly, they (n=18) referred to the moral value and cross-disciplinary aspect, which strengthened their awareness and experience, altering their perspectives on learning altogether. Hence unanimously, (n=18) the *moral value* of designing learning to improve one's community was deemed the catalyst which maintained their level of *perseverance* to mitigate tensions which will be further discussed in the next question. The real-life aspect of the pedagogy was deemed the strength of the intervention and the impetus that made their work valuable. From a phenomenological perspective, their frames of mind were shaped by the experience in and of the world as they engaged in the community. Teachers (n=17) found themselves in a problematic situation of solving a community issue and appeared puzzled by the combination of "*self and community*". Arguably, it is the shared experience around the emergent problem and *purposeful* interaction of the *individual*, those inner and outer reflections and conversations and their engagement with others in the *community*, which contributed to transforming their mind frames about Syrians and Lebanese, and their learning together, also increasing learners' *social* and *emotional capital*. Similarly, to complex ecological systems (Cilliers, 1998), those changing perspectives cannot be attributed to one factor but to their intertwined interaction, similarly to complex ecological systems (Cilliers) and a multiplicity of actors, bridging in and out of classroom learning with inner-outer thoughts, impacting, and changing beliefs and the constraints of school and societal structures. Unanimously, (n=18) the *moral value* of designing learning to improve one's community was deemed the drive of the project which maintained their level of *perseverance* to mitigate tensions, which will be discussed in Section 6.2.2.

6.2.1.3 Information and Communication Technologies (ICT). At first, science (n=10) and technology (n=8) teachers thought that the intervention was about ICT. Their perspectives evolved during the intervention, from being *anxious* about their low level of ICT skills, to feeling *uncertain* about the open-ended *emergent* aspect. All teachers (n=18) needed additional skills and time to practise before engaging confidently in classroom implementation. In the first year, this tension was exacerbated by the delay in the distribution of ICT, which provoked additional focus on the pedagogy. However, the relationship between ICT and pedagogy was *intertwined*, and neither worked without the other. Thus, the further they engaged in the pedagogical process, the more they gained and honed their technological skills.

It can therefore be contended that the mediation of ICT in the pedagogical process contributed to higher skill levels, which were acquired as a spin-off from the pedagogy, similar to the studies analysed by Somekh (2008). Hence, it can be argued that the changing nature of learning and being exposed to just enough ICT at the start of the intervention reduced the risk of subscribing to deterministic views. Furthermore, making time for teachers to understand *ICT affordances* appeared to impact practice, demystifying the computer as a “big black box” and engaging students with otherwise abstract concepts. Seemingly, this approach was appreciated as compared to distributing ICT tools and providing instructions to follow. Finally, despite the initial excitement of using ICT, there was a lack of apparent evidence that ICT alone was the force driving innovative practice.

6.2.2 How are teachers experiencing this learning intervention, what is working or not, what tensions are they experiencing, and how are they mitigating them?

The intervention provided a *collaborative structure* for teachers’ learning. Teachers learnt and applied their learning according to their *professional needs*. They applied their learning and designed different projects to meet their learning objectives. Thus, the skills that they gained did not appear linearly delineated or similar for all teachers. Furthermore, shared experience, conversations, and reflective processes with colleagues across schools contributed

to their professional growth and could be compared to professionals participating in a nascent Community of Practice (Lave & Wenger, 1991).

The shared process contributed to opening their minds to new perspectives and being conscious of stereotypes and epistemological beliefs. They *appropriated learning* and demonstrated it in utilising what they learnt to design projects that varied according to students' interests and world or community perspectives. They (n=17) reflected on *practices* and were able to *project themselves* into the short-term future by designing projects for school implementation. As mentioned in Section 6.2.1.2, all teachers experienced tensions because the pedagogy appeared to contradict their cultural practices, their habitus, and systems of thinking, their beliefs, and the principles they applied in practice. Those tensions encompass having a framework as compared to following instructions, dealing with the concepts of self and community, knowledge-building processes, and shifting to designing solutions, uncertainty, and bureaucracy. They are explained hereafter.

6.2.2.1 Framework vs Instructions. Teachers were provided with a *framework* to engage with the concept of emergence – the Creative Process – which took them out of their comfort zone and the *habit* of relying on instructions in textbooks. It left them (n=18) *uncertain* of being on the right path and *anxious* (n=4) when they could not find a solution or see (n=17) the full picture of the “puzzle” (post-intervention debrief). They dealt with uncertainty through the dynamics of exchange in the TPD and were able to shape their thinking through intersubjectivity, making meaning together from what seemed very confusing to everyone. As explained by Habermas (1985), teachers (n=17) mutually generated a common understanding, which allowed them to feel safe, take risks, and step out of their habitus to design a project. In other words, what they did together, they could not have done alone, which can be argued is a *collective* dimension to agency in practice.

6.2.2.2 Self and Community. As mentioned in the findings, at the start of the experience, teachers (n=18) had undervalued the “*self and community*” concepts, which

became challenging to discuss with students – both Syrians and Lebanese. In fact, those concepts are not dealt with in practice. This tension could partly be attributed to the focus of the Lebanese curriculum on content, and partly to the fact that politics and community problems are avoided in Lebanese public school life. To mitigate those tensions, teachers felt safe, with a few exceptions, to maintain the boundaries of the community to the school, as it was common ground to all students.

On the other hand, this could be viewed as an opportunity because it nurtured positive and inclusive *relationships* around learning, countering feelings of *exclusion* and *discrimination*. Those relationships were at the *inter–intra* level for teachers, their students, and the wider school community. Indeed, problems such as sexual harassment in school toilets or Aicha's visual impairment were relevant to the entire school community. In addition, sexual harassment is a taboo, not spoken about at school or in the wider community and thus the mere fact of addressing the problem transformed everyone's perception about what is possible, and communication became more open at school.

As emphasised in the findings, with one exception, it transformed the dynamics around learning, influencing *school culture* and perceptions about the *individual*, *the self*, and other(s). Teachers, with some variations, emphasised that students felt better about themselves too – Fatima's and Ali's students were striking examples. As explained by the teachers, such an impact is not negligible and validates previous research findings with refugees (Hawker, 2015). Thus, we can argue that those connections and relationships were complex, involved a multiplicity of actors, and evolved ecologically, bridging in- and out-of-school cultures.

The interactions involved all stakeholders – teachers, their peers, students, principals, community members, trainers, volunteers – generating trust and blurring boundaries. The authoritative habits of controlling and telling students what to do was replaced with negotiating community problems. Teachers (n=17) reciprocated as they became learners too. This bridge between in- and out-of-school learning impacted individuals, cultural practices, schools, and

social systems. Learning, except for the opposing teacher, became more generative and inclusive, and people were more open to new perspectives. Arguably, it allowed teachers (n=17) to know their students and give them space to connect with themselves, each other, and community members, and relate to issues that they cared about, to express themselves, and to be viewed as people (not only as displaced or incapable learners), to discover their capacities and potentials and become better learners. Such learning arguably provided a space for learners to shape their own identity, as they gained *social* and *emotional capital*.

6.2.2.3 Knowledge-Building. Teachers' appropriation of learning depended partly on how they made meaning of the *knowledge-building* experience during the intervention. Their habitual practice was to control and tell students what to do; thus, negotiating problems with students generated a tension which they were able to mitigate as they became better listeners. They (n=17) negotiated with students and invited them to question their community, identify and address problems, conduct research, design, and create artefacts. Indeed, all teachers (n=17) were able to engage students in creating projects of interest to students and connect project work with overall learning goals, yet fewer teachers (n=7) were able to engage students with theory around the concepts in projects. Evidence of this was in teachers' ability (n=7), or lack of (n=11), to integrate science concepts into their project designs.

Teacher Amira, using the example of ultrasound waves, was able to relate the project to physics concepts – and to engage students in “what if” situations. In such cases, similar to knowledge-building processes, teachers (n=7) found that the veracity of the knowledge produced was worth pursuing and sharing. Generally, teachers (n=11) were in search of the right solution without necessarily questioning their assumptions. This could be explained by the tenacity of the notion of scientific method emphasised in textbooks (Kurup, 2014) and the description of *scientific knowledge* as an orderly, rational, and step-by-step process, enabling students to reproduce experiments that scientists have conducted. Arguably, knowledge-building is a process that requires more investment from teachers over time.

6.2.2.4 Shifting Modes of Thinking. As explained by Scardamalia and Bereiter (2017), shifting modes of thinking between knowledge-building and designing a solution is challenging. Teachers explained that they had conducted research before but could not imagine how to *design a solution*. Some of them skipped that phase (n= 10) and created an artefact which arguably ended in simplistic solutions, which missed the potential of knowledge-building. Others (n=7), such as Amira, Nada, Hiba, Fatima, Ali, Mahmoud, and Karim, engaged in the process iteratively as they shifted between modes of thinking. Laurillard's *conversational framework* (2002) provided conceptual tools to establish the transition from the discursive to the theoretical level. Hence, teachers (n=7) learnt from what worked and did not but had to step back, reflect, sketch, design, and explore possibilities based on which they re-evaluated hypotheses before creating artefacts. The example of Amira illustrates the challenge to go between one mode and another, and the tendency of teachers to jump to create a prototype without questioning assumptions. Teachers (n=7) who shifted modes of thinking in their implementation engaged with ideas, socialised, and explained them. Their projects (n=7) were open-ended, and ideas were treated as improvable and objects of inquiry as explained by Fatima.

6.2.2.5 Uncertainty. Generally, all teachers were stressed by the concept of emergence and the uncertainty it generated. As explained in Section 6.2.2.3, in the case of Amira, uncertainty was exacerbated by anxiety and worries that she wouldn't be able to find a solution. Similarly, computer teachers felt uncertain with the introductory knowledge of Python gained and expressed the need to learn it in more depth, to be more confident and ahead of their students' knowledge. Nevertheless, teachers (n=18) were able to mitigate those tensions. They invested additional personal time, to learn, enquire about, and question practices, building further on the relationships around learning in the TPD, at school and in the community. The relationships nurtured in the intervention were beyond trainer-teacher "dyadic relationships" (Daly et al., 2020, p. 653). As Daly et al. (2020, p. 653) remind us, those relationships developed around learning should not be underestimated within the rigidity of school systems.

Arguably, those ecological relationships around learning help teachers to deal with this uncertainty and make a favourable impact on hierarchical school systems.

6.2.2.6 Bureaucracy. Engaging students to participate in teams was a point of tension for secondary-level teachers because there were too few secondary-level Syrians in their classes. This was discussed during reflective moments, at the start of the interventions; and to mitigate this tension, teachers had to work with students from various classes during breaks, after school, and sometimes during their holidays. All those efforts required additional time and commitment from teachers. In addition, opening schools during holidays or having afternoon-shift children participate in project work with morning-shift schools required permission. Policies in public schools are set by MEHE and obtaining permissions takes considerable bureaucracy and documentation, is time- and energy-consuming, and causes increasing tensions for teachers and schools. This applied to participating in the intervention working sessions and events, since teachers were accompanied by teams of students. Yet despite the bureaucracy, teachers and school leaders were able to stymie those tensions to ensure that they could continue working with students.

6.2.3 What was the process like for students to think and create their artefacts and how does it relate to their learning?

The third question cannot be answered since students' perspectives were not collected within the boundaries of this research. Similarly, the next question is addressed from teachers' perspectives only.

6.2.4 What value do the artefacts represent to the students, teachers, and principals?

The artefacts represented personal and professional satisfaction for the teachers (n=18). At first, teachers (n=18) associated creating a functional artefact with *success*. This view evolved (n=7) to represent the learning that had taken place and teachers expressed interest in continuing to improve the artefacts in the future. They were proud of their achievements and of being recognised at school and on social media. As teacher Ali mentioned, they were viewed

differently at school and felt important. Arguably, this increased teachers' social capital alongside strengthening their professional identities.

The connection with learning was important and varied depending on the depth with which they engaged in the process of knowledge-building. Irrespective of the learning that resulted, teachers emphasised that the artefacts were meaningful to them (n=18) and to the wider community because they were created to improve something around them. As emphasised by research around maker-spaces (Bowler, 2014; Vossoughi, 2014; Vossoughi et al., 2016), making and constructing should have a purposeful aim to sustain motivation. Finally, it represented their professional growth and the learning that took place, not only in terms of concepts taught to students but acquiring a process of building knowledge and using ICT for a purpose.

6.3 The Problem of Refugee Learning in Lebanon

The rationale of the research is around refugee education in Lebanon and explores a situated intervention with public school teachers. The findings presented in Figure 11 show a stark contrast between the problems described in Chapter 2 – as visualised in Figure 2 – and the learning fostered which impacts the lives of refugees, their Lebanese peers, and the school community. This is explained hereafter.

6.3.1 Learning Fostered

Before the intervention, teachers complained of motivation to teach and learn. They raced to cover the content of a dated curriculum to prepare students for exams and faced a range of challenges including controlling students who had unpredictable violent behaviour, difficulty adapting to the culture, and a fear of corporal punishment. They described learners as introverts with low self-esteem and isolated from the community. The situated nature of the intervention provided a structure for teachers to design projects mediated by ICT, to mitigate tensions, and to turn tensions into opportunities, impacting the learning and lives of students – refugees and their Lebanese peers.

Thus, as opposed to school violence, disinterest towards learning, and cultural alienation, learning became motivating, students were able to express their interests, and were confident and adapted to the learning culture. Learning was collaborative and communication was transformed when teachers negotiated questions to explore, and students reciprocated in solving an emergent community problem. The forged relationship nurtured social cohesion, and countered feelings of isolation and discrimination. Those contrasts are summarised in Table 11.

Table 11.

Learning before and after the intervention <i>Classroom learning</i>	Intervention
Teacher-centred	Learner-centred
Industrial, content coverage, rote learning	Knowledge-building, emergent problem-solving
Hierarchical communication	Negotiation of learning
Control	Reciprocity
Demotivated	Motivated
Isolation	Relationships, connections, “self–community”
Individual	Collaborative
Violence	Social cohesion
Low self-esteem	Self-confidence
Acculturation	Adaptation

The intervention was implemented in morning-shift schools, where refugees learnt with their Lebanese peers, providing evidence that refugee education could be approached

differently. Arguably, the combination of emergent problem-solving, and the ecological, nested interrelation around learning, engaging the self, others, and the community, contributed to linking social structures with systems of beliefs around project work.

6.3.2 Systems of Beliefs

The findings and the three examples given in Chapter 3 (Smart Glasses for the Visually Impaired, Detector of Two Persons in a Toilet Cabin, Safe School) reveal changes in systems of beliefs: (a) at the micro level, teachers' perceptions on refugees evolved; (b) at the meso level, the project impacted the culture and social structures around learning at school; (c) at the exo level, parents (e.g. Ali's student's parents) came to enquire about the change in their children's behaviour; (d) at the macro level, it influenced sociocultural stereotypes; for example, Aicha's parents trusted Ali's students, two Syrian boys, to work in their home, with their daughters, reversing deeply anchored sociocultural taboos, in a conservative region, that does not encourage relationships, let alone between females and males of the same community. Arguably, those ecological connections contributed to counter feelings of resentment, low self-esteem, lack of belonging (Kohli, 2011), and status, increasing refugees' emotional and social capital (Ager & Strang, 2008).

6.3.3 Learning Together

The transformed beliefs at multiple levels – micro, meso, exo, and macro – began in the classroom and were possible arguably because teachers designed collaborative learning that extended into the community, and policy allowed refugees to learn with Lebanese peers in the morning shift. However, this is not the case for segregated afternoon-shift schools unless community afterschool projects could be envisioned and accepted by policymakers. As mentioned in Chapter 2, tensions are often felt but not spoken of in schools and the community. Arguably, the relationships nurtured while learning together should not be underestimated because of their potential to transform feelings of fear and resentment that may have become embedded in the community. Such potential requires that policymakers consider the problem of

refugee education with the long-term impact of segregated learning, not only on refugees but on the society where they are living.

6.3.4 Lives Not Numbers

In the post-implementation interview, Ali referred to his student as “*a saved life*” who otherwise would have been just another additional dropout figure in reports. Amira, Randa, and Fatima seemed similarly compelled by the change in their students’ commitment to pursuing their education for their future. Arguably, the impact on learners would not have been captured in school achievement reports. These compelling cases show the transformative potential of education on learners when learning is a meaning-making process, unlikely to be reached by current reductionist and industrial approaches to learning. Thus, how many of the 1.5 million refugees in Lebanon could be saved from becoming just another dropout number in reports if learning became a meaning-making process?

6.4 Agency in Practice

The notion of agency adopted in the research is ecological, temporal, and rooted in teachers’ past experiences, backgrounds, and beliefs, yet orientated to the future through the setting of goals, and the ability to envisage future possibilities, but acted on in the present (Priestley et al., 2015). Such an ecological, temporal understanding emphasises the dialogic interaction between teachers’ evolving cultural practices, the present TPD experience through which teachers learnt collectively to design a project, and the pedagogy that they appropriated and implemented at school. The dialogic interaction was observed iterationally, as a phenomenon of teachers’ present engagement in the TPD intervention, enabling them to project themselves into the future. These three dimensions are explained next.

6.4.1 The Iterational Dimension

Agency was exerted in an iterational process, impacted by, and impacting on, teachers’ habitus, their personal and professional backgrounds, and shaping teachers’ (n=4) professional identities. Indeed, teachers’ perspectives and mind frames evolved, grounded in the

interpretation of the intervention, especially during shared group reflections, and its implementation in practice. Nonetheless, it could be argued that personal health issues negatively impacted the opposing teacher's agency and that the uncertainty of the emergent process generated anxiety for teachers (n=1) such as Amira. It can be further argued that had Amira not adapted pedagogical processes, questioned practices, and re-evaluated the purpose of designing a solution, feelings of anxiety could have impacted her agency negatively.

Nevertheless, the iterational process was fluid, with constant backward and forward reflections on teachers' professional role, what they did in the past, how they were thinking during the intervention, how it impacted practices, and what they could do in the future within the constraints of the context and school environment. This was observed during working sessions, debriefs, and post-implementation interviews with teachers' capacity to question prior beliefs and practices, and to engage with innovative knowledge-building pedagogy. Thus, their agency was conflated by their ability to question habitual practices and anchored beliefs, to adapt pedagogical practices, and to imagine what they could do in practical terms at school.

It is possible that the nearing age of retirement for the opposing teacher, coupled with personal and health problems, influenced her agency, preventing her from projecting herself into the future. Thus, agency was manifested in her own ability to learn, without influencing classroom pedagogy, and reinforced by enduring habitual practices to "show and tell". In addition, professional gains seemed obscured by stereotypes and diminished views of learners, preventing students from engaging collaboratively with peers in knowledge-building. Arguably, her motivation to adapt cultural practices and stereotypes were further reduced, partly because the circumstances at her school exacerbated personal and professional tensions, with no ICT teacher at school, rendering the journey a solitary one.

The difference in manifestation of agency between the opposing teacher and her peers could be compared to teachers' reification of Sachs' managerial or democratic professionalism (Sachs, 2001, pp. 152–160). Teachers Amira, Randa, Fatima, and Ali, for example, exhibited

signs of democratic professionalism, driven by internal motivation and informed by the articulation of values and purpose. Their agency seemed outward-orientated towards improving their students' learning and lives, underpinned by strong moral values towards improving the community. In comparison, the opposing teacher's agency seemed inward-orientated – learning for her own sake – and her professionalism could be considered managerial, with external motivation to develop technical skills disconnected from cultural practices.

6.4.2 The TPD Intervention, Present Dimension

Teachers' shared experience in the intervention impacted their epistemological and sociocultural beliefs driving habitual practices and classroom decisions. These evolved progressively during the reflective conversations around the subjective, objective, and social world, as they transformed tensions into opportunities to improve things around them. Thus, discursive conversations between teachers provoked inner and outer dialogues which were maintained in practice with students as they negotiated learning, and gave them space to think and solve emergent problems. Interestingly, the initial excitement about ICT was overshadowed by the excitement around the emergent pedagogy to improve one's community learning. Similar to more general research in the field of education (Fullan, 2001), we could confirm that past the initial motivation of discovering ICT, there was a lack of apparent evidence that ICT alone could drive and sustain agency.

On the other hand, agency seemed triggered by the multiple connections generated in the TPD around knowledge-building and teachers' ability to project themselves into future school implementation. This echoes analyses around teachers' use of ICT in practice, with the premise of pedagogy as guiding principles about ICT, and pedagogically focused approaches in TPD (Loveless et al., 2006; Cox et al, 2004; Webb & Cox, 2004). Making those connections – between, people, ICT, community problems, and pedagogy – appeared challenging at first, yet also stimulating and motivating.

As explained by Scardamalia and Bereiter (2005), it requires a constant shift between

different modes of thinking – knowledge-building and design thinking. Teacher agency arguably emerged from those contradictions as they made meaning and themselves experienced those multiple connections and tried to project themselves in designing a project. These tensions resulted partly from uncertainties around the concept of emergence, their epistemic agency, and knowledge of what to do, and the engagement of the individual venturing into the community. Concomitantly, these tensions challenged previous epistemological beliefs and sociocultural stereotypes, and the habitual reliance on declarative knowledge and scientific experiments with right/wrong solutions.

Thus, these tensions around agency could be viewed as opportunities, provoking discursive dialogic and reflective thinking, shaping and transforming beliefs, as they confronted problematic situations with the emergent pedagogy, invested themselves in the community, discovered students' capacities, and their own abilities to make a difference in the lives of their students. These were moments of consciousness of cultural and transformative mind frames impacting their decisions.

Similar to activist teachers (Sachs, 2003), teachers (n=4) became active actors, and agents of change, impacting habitual practices, and social structures at school and in the community. As mentioned in Section 6.1, this was observed during the shared conversations, working sessions, and interviews as teachers described the transformed dynamics around learning, sociocultural stereotypes, and previously held discriminatory views, transforming habitus and structures, at school and in the wider community; for example, learning and working together, or Syrians being welcome in the home of Lebanese students. Thus, the process-orientated intervention appeared to shape teacher agency, generating more relevant, open, and inclusive learning, transforming the discourse around learning, and impacting practices and social structures at school and in the wider community.

6.4.3 The School Implementation – Practical, Evaluative Dimension

Teachers appropriated learning, designed projects, and had to face bureaucratic and

policy constraints. As explained in Section 6.4.1, the opposing teacher rather exerted her agency with little demonstratable efforts to engage Syrian children. On the other hand, the other teachers became active in affecting change gradually, as they gained confidence and nurtured ecological relationships – with principals, peers, students – establishing trust around learning at school and the wider community. What became important was the learning around project work which catalysed everyone’s energy, from the gatekeeper to the principal, and extended after school, remaining open for students to work, even in the holidays (as discussed in the post-implementation debrief).

Arguably, the combination of individual and collective dimensions around learning seemed to open doors. Thus, the question became how we could solve the problem collectively. Although driven by teachers, this appeared to change the power relationship around learning, from the individual to the group around the actual activity, as a shared responsibility. The process appeared to transform entrenched sociocultural stereotypes, top-down communication, and bureaucratic processes. As mentioned earlier, these were observed at the micro-, meso-, exo-, and macro-system levels. These dialectic relationships around the activity promoted agency and countered bureaucracy and policy tensions, impacting social structures and enabling collaborative learning between Syrian and Lebanese students. This demonstrates the importance of relationships shaping agency within the triadic formulation of agency, social structure, and practices.

As emphasised by Daly et al. (2020), nurturing such relationships in schools should not be underestimated and “ecological perspectives helped to locate the learning of teachers as individuals within an understanding of schools as complex environments, which are dynamic and require their members to constantly negotiate the shifting contexts, both personal and resource-based, in which they operate” (Daly et al., 2020, p. 653). Furthermore, the relationships and connections nurtured by teachers around learning could not be seen independently from the other, yet combined, they influenced structures and systems. Thus, the

dynamic and complex relationships and connections appeared to shape and be shaped by agency, which was in continuous interaction with structures and systems. Thus, we could say that these relationships were generative, forming an eco-system around the duality of the relationship of agency, structures, and systems (Giddens, 1984).

Finally, teacher agency appeared to be temporal, ecological, and intertwined in complex dialectic relationships and connections, between collective and individual dimensions in the shared experience, and in actions taken at school and in the community around learning. Thus, agency was not only dependent on the intervention mediated by ICT, but on those interactions between cultural practices and social structures within the constraints of the context, policy, and the school environment. Although these dimensions are explained sequentially, the connections and relationships between them evolved ecologically as teachers' projective actions challenged past cultural practices and informed current practices, influencing social structures, transforming them to be more open, and generating social cohesion and harmony around learning.

6.5 Limitations of the Study

The study is situated and qualitative and aims to explore what learning is fostered when teachers engage in a low-cost, problem-orientated, technology-enhanced learning intervention with refugee children. It does not aim to generalise the intervention or the type of learning that took place for all teachers working with refugees. Yet, it unveils the untapped potential of situated TPD interventions to professionalise teachers and nurture teachers as agents of change (Kennedy, 2014). The construct of teacher agency in practice (Chaaban et al., 2021) remains underexamined, particularly in the refugee context and the limitation of the study with teachers in Lebanon is also acknowledged. The study adopted Biesta et al.'s (2015, 2017) situated, ecological, and temporal nature of agency which is examined within complexity thinking. The study acquiesces the lack of apparent evidence that ICT alone is a force driving innovative practices (Fullan, 2001). In addition, the transformed cultural practices and their

impact on social structure in the context of the study were limited to teachers engaging refugees in the morning shift and learning with their Lebanese peers.

At the start of the research, it was mentioned that the same teachers teach in the morning and segregated afternoon shift, with less hours and reduced schedules. Hence, the study may not apply to afternoon shifts, nor can it be generalised to other situations without adaptation and contextualisation. Aside from policy, it would require adaptation of the TPD to the context in addition to considerable efforts from teachers and schools to find time to work on the projects with students. This would mean heightened stress for teachers and the need for ingenuity to find ways to engage with the wider community.

7 Conclusion

This chapter concludes the research report with three sections: the conclusion that summarises the research, its aims and findings; its impact on professional practice; and its contribution to knowledge.

7.1 Conclusion

The main question that the research aims to address is how to build teachers' capacities in the context of refugee education. The research explored a situated, contextual intervention designed to engage teachers of refugees in a problem-orientated, low-cost technology-enhanced, learning experience in morning-shift schools where Syrian refugees learnt with their Lebanese peers.

7.1.1 The Problem

The core of the problem was presented at the intersection of teacher professional development, pedagogy, technology, and curriculum and explored how teachers may integrate, with some variation, a socioconstructivist knowledge-building approach to make learning a meaning-making experience by engaging students in solving problems of interest to them, and making connections between curriculum objectives and the underlying concepts within those problems.

The context of education in Lebanon provides an industrial type of education that stopped renewing itself since its civil war of 1975–1990. The problem of Syrian refugees as a context for this research was described as a crisis within a crisis, with resentment between the two populations to learn together, school violence, sociocultural stereotypes, and segregated afternoon-shift schools. At the time of writing this report (2021–2022), Lebanon was undergoing its worst political and socioeconomic crisis, and the country was described as dysfunctional with a lack of governance (Khouri, 2016) and unresolved conflicts. The complexity of the context and the impact of policies around Syrian refugee education in Lebanon are recognised, including the lack of sense of identity, unequal opportunities, reductionist views of learning, acculturation, and the inability of refugees to project themselves in the future. The research examined the problem of Syrian and Lebanese students learning together because the same teachers teach in the morning and afternoon shifts and there were no afternoon shifts for secondary school-age refugees. Hence, those in the system were only learning in morning-shift schools or were not in the system at all.

7.1.2 Situated Intervention

The situated TPD intervention mediated by ICT provides an *antithetical model* to general norms of “deficit and cascade” TPD (Kennedy, 2014), deterministic views of ICT, and unidirectional, teacher-centred pedagogy. The intervention is designed with teachers as learners and the concept that pedagogy can be determined by practice. It proposed a TPD intervention designed to engage teachers in their own learning around knowledge-building, social good, and their lifeworld (objective, subjective, and social) to nurture awareness and consciousness in problematic situations. All of those constructs, in addition to having Syrians and Lebanese learning together, were incongruent with sociocultural stereotypes and contradicted cultural practices, systems, and structures of learning, at school and in society. The professional growth of teachers and the collaborative learning that emerged showed a stark contrast in learning, a forging of new relationships, and the nurturing of social cohesion, and a

counter of feelings of isolation and discrimination.

7.1.3 Teacher Agency

The research aimed to understand teacher agency through a qualitative analysis, using individual and group interviews, and observations. The research used Pachler et al.'s (2010) sociocultural triangular relationship between *agency*, *structures*, and *cultural practices*, as a guiding grid and analytical framework. The relationship between them was presented using the “problem spaces” of technology-enhanced learning (TEL, Turvey & Pachler, 2016).

Provisionality, uncertainties, and fragmented identities of teachers and learners, though for different reasons than in problem spaces, appeared salient in the postconflict context of the intervention. Elucidating the problem from the angle of problem spaces with complexity thinking enabled the focus of the research to stay away from linear thinking, to tease out and discuss the findings, and to visualise how tensions converged into opportunities. In retrospect, the analytical framework and research could have been further enriched by linking it to policies and the politics of refugee education, beyond the description of those tensions in the context for the study.

7.1.4 The Potential of TPD as Agent of Change

The research shows the potential of situated and transformative TPD to professionalise teachers in postconflict contexts of refugee education, and sheds light on the crucial role of TPD as a potential agent of change to generate ecological relationships around teachers as actors. This is in line with research around TPD (Daly et al., 2020) and schools as complex environments, emphasising the importance of relationships in school change (Hargreaves & Fullan, 2012). Thus, the learning that emerged showed an impact on teaching and on the lives of students. While some of the things that the teachers did may appear trivial, they provided a context for learning that was non-threatening, bridging in- and out-of-school learning, and unveiling a potential to transform existing school systems, traditional forms of control, and authoritative classroom learning. Hence, the TPD as a shared experience combined with the

emergent pedagogy enabled ecological relationships to be nurtured, transforming power dynamics around learning outside of the boundary of classroom learning. The boundaries, established in the shared learning experience, between past, present, and evaluative-projective relationships, as explained by Biesta et al. (2015) were fluid. Thus, teachers' past beliefs and practices interacted with the present experience in the intervention, and their future actions. The temporal flow was continuous, between the personal and the professional, the collective and individual exchanges, the inter–intra conversations, thoughts, and actions.

Similar to Hargreaves and Fullan (2012, p. 7), and as emphasised by Daly et al. (2020), the research revealed the importance of those ecological relationships around teachers' learning and their agency in practice. They became catalysts of individual and societal mind-shifts in rigid school systems, curbing cultural practices, shaping identities, and increasing social and emotional capital for teachers and learners. Thus, the dynamic and complex relationships and connections nurtured in the TPD formed an ecological system around the duality of the relationship of agency with structures and systems (Giddens, 1984).

Learning through communicative action and Habermas's (1985) lifeworld (objective, subjective, and social) was drawn on in the intervention to help teachers become aware and conscious of their evolving mind frames as they faced problematic situations. Laurillard's conversational framework (2002) was shown to be effective to transition from the discursive to the theoretical level.

The intervention tied teachers' professional growth with emergent knowledge-building mediated by ICT, generating a transformation in relationships around learning. As such, it can be seen as a complicated process that is not generally favoured by policymakers, particularly in postconflict situations. It differs from general norms that rely on "deficit and cascade" (Kennedy, 2014) models, and narrow visions of effectiveness and learners' achievements. As stressed by Daly et al. (2020), for those ecological relationships to be nurtured around learning and to normalise them within school cultures, there needs to be wider acceptance by policymakers,

leaders, and teachers that, for everyone, professional learning is predicated on an intricate web of interrelationships and dependencies.

7.1.5 Pedagogy

The research suggests that knowledge-building pedagogy and emergence could work even in challenging contexts. The concept of emergence opens new perspectives as to what learning as making could be, valuing opportunities for provisional thinking, including risk-taking and critical inquiry. Thus, the research stresses the pre-eminence of pedagogical innovation (Scardamalia and Bereiter, 2016) which could be leveraged in learning in maker-spaces mediated by ICTs. Teachers appropriated knowledge-building and emergence and their appropriation depended on their ability to engage with the uncertainty it generated and to make connections with curriculum goals. Those who were able (n=4) to embrace emergence engaged with the intellectual risk-taking required, building on ideas in the way proposed by Scardamalia and Bereiter (2005), while those who focused on creating artefacts with ICT (n=11) benefited from the learning around constructing and assembling in the way described by Bevan (2017, p. 81) and O'Brien et al., (2016).

The pre-eminence of pedagogy mediated by ICT with the learner at the centre of their own learning provided a dynamic eco-system of relationships that can leverage making in learning, creating a bridge between in- and out-of-school cultures. The research emphasises findings around maker-space research that suggest that making with a purpose generates an intrinsic motivation to pursue one's goals and help build learners' social and emotional capital to contribute positively to the community around them, away from a culture of consumerism and productivity (Weiner et al., 2020; Vossoughi & Bevan, 2014) placing learner and social good at the centre of learning.

Making in learning, similar to learning mediated by ICT, had meaning around the activity, context, and culture in which the students were taught. Comparable to research around pedagogy and ICT by Webb and Cox (2004, p. 278) and Selwyn (2011), there was a lack of

apparent evidence that ICT alone was the force driving innovative practices. However, the adaptation of pedagogical reasoning and practices required were generated in tandem, and consequently, learning about ICT and transforming pedagogical practices informed each other similar to studies by Loveless (2011) and Somekh (2008). In addition, the research unveiled aspects of the openness of non-complex ICT tools in maker-spaces, raising new questions about the untapped potential of learners' relationship with technology.

7.1.6 Agency

The notion of agency adopted builds on the seminal work of Emirbayer and Mische (1998), Biesta et al., (2015) and Pachler et al. (2010, p. 4), as the capacity to achieve, to act on the world, of being in the world. Agency is understood as sociocultural, ecological, and temporal, rooted in teachers' past experiences, yet orientated to the future through the setting of goals, and the ability to envisage future possibilities, but acted on in the present (Biesta et al., 2015).

Teacher agency in practice appeared as ecological, temporal, complex, and intertwined in dialectic relationships around emergent knowledge-building pedagogy, between collective and individual dimensions in the shared experience, and in actions driven by moral values, in school and in the community. Thus, agency in practice was manifested at the confluence of those dynamic and fluid ecological relationships nurtured in the TPD mediated by ICT, thinking, and doing during school implementation.

While the literature suggests that beliefs play an important role in teacher agency in practice, there seems to be a discrepancy between what teachers believed, their epistemic agency, and wider institutional cultures. This indicates that teacher agency in practice does not just rely on the beliefs that individual teachers bring to their practice but requires collective development (Biesta et al., 2017) as seen in the extended relationships generated around solving an emergent problem during the shared experience. Thus, agency was not only dependent on the intervention, but on teachers' ability to make connections between the TPD

mediated by ICT, the emergent pedagogy, their cultural practices, and the wider context of school and social structures converging tensions into opportunities.

In accordance with Scardamalia and Bereiter (2005), the emergent pedagogical model through a point of tension enabled teachers to make a series of connections as they extended this impact from school to the community, turning it to be a driving force towards more agentic actions. As they mitigated tensions around the concept of emergence, they turned those into opportunities, revealing a collective and fluid dimension of agency (Scardamalia & Bereiter, 2005). Similar to Hargreaves and Fullan's (2012) emphasis on a collective dimension supported by leadership at school, which encourages teacher agency and motivates teachers to take action,

people are motivated by good ideas tied to action; they are energised even more by pursuing action with others; they are spurred on still further by learning from their mistakes; and they are ultimately propelled by actions that make an impact—what we call “moral imperative realized”. (Hargreaves & Fullan, 2012, p. 7)

7.1.7 Refugee Education

The knowledge derived from this research reveals that teachers as actors can make learning more inclusive and non-discriminating, and can counter problematic frames of reference that stigmatise and dehumanise refugee education and public school learners. *The pedagogical model complements the four frameworks of refugee education* with knowledge-building, innovation, and emergence. The core domains complement “success, safety and belonging” (Kohli, 2011, p. 314), human rights with recognition, redistribution and representation (Fraser, 2003), and Bronfenbrenner's (1992) ecological framework.

The four frameworks of refugee education provide solid grounds for future educational development, and it would benefit the field to consider visions of education for refugees that enable knowledge-building processes. These dimensions may be important for all learners: the argument is that they are even more important in postconflict contexts for refugees and

vulnerable learners to develop a shared sense of community, belonging, and sense of identity which is missing in their lives. It provides a human aspect to the problem of refugee education and shows that refugee education could be different contingent on (a) policies that adopt long-term visions of education and enable refugees to learn with the host community and (b) the provision of teacher professional development that promotes agency.

The research shows that the hostilities or resentments that stand in the way of learning in postconflict situations (Chelpi-den Hamer, 2011) can be addressed through collaborative and purposeful interventions. In addition, by studying the problem of refugees learning with host communities in public schools, the research unveiled blind spots in public schools with entrenched sociocultural stereotypes categorising both groups – Syrians and Lebanese – as being incapable, preventing teachers from perceiving their potential.

To attend to the refugee education crisis, *the professional development of teachers of refugees* deserves particular attention at a global level, away from “transmissive, deficit” models (Kennedy, 2014, p. 693) and deterministic views of ICTs. The research revealed that situated TPD can be used even in challenging, postconflict contexts. The research provides an alternative view to deficit models of TPD, unveiling how a situated approach may contribute to developing contextual solutions to the problem and enhance teachers’ professional growth. Without claiming that it aims to be replicated, the research calls for the generation and nurturing of contextually relevant teacher professional development solutions that increase teacher agency through transformative models.

7.2 Implication for Professional Practice

Our practice is at the confluence of politics and policies that govern social work and education, and unfortunately those are sometimes guided by a narrow vision of teacher professional growth and guided by standards for ICT rarely married with pedagogical practices for teachers, and emphasising ICT skills, achievement figures and access to schools.

Acknowledging that this research is a learning process has enabled the examination and

questioning of an organisational strategy and plan for future TPD interventions with teachers, schools, and communities. The research enabled to develop and articulate IEA's theory of change, to build on lessons learned and to plan future steps with confidence.

7.3 Contribution to Knowledge

What does this research add to knowledge? The research contributes to the field of education generally, and teacher professional development and refugee education in the following aspects:

In the field of teacher professional development (TPD), the research

- Provides a framework of situated teacher professional development;
- Demonstrates a route to teacher professional growth which is not linear or prescribed in a context that generally relies on “cascade and deficit models” (Kennedy, 2014, p. 693);
- Shows that teacher professional growth is not necessarily linear or focused on learner achievements;
- Unveils the importance of shared conversations in TPD to better understand change processes and analyse little-understood problem of constraints inherit in challenging contexts;
- Contributes to understanding the constraints on teacher agency and how tensions may be turned into opportunities.

In the field of refugee education, the research

- Emphasises the central role of teachers and the pre-eminence of their professional growth;
- Unveils what refugee education could be, the missed potential of millions of people, and the impact on the society where they live;
- Humanises the problem of refugee learning, beyond staggering dropout rates and numbers in reports;

- Raises the urgency to attend to the problem with a long-term view of education beyond immediate access to school, reductionist views of learning, and deterministic views of ICT;
- Sees teacher agency as an ecological, temporal, and complex construct which may thrive to provide a context of learning that is more relevant to the needs of refugees;
- Counters sociocultural stereotypes and diminished views of refugees and vulnerable learners in public schools;
- Fills an equity gap surrounding refugee education research mostly conducted in high-income countries (UK, Canada, US, Australia) while 86% of the 60 million-strong refugee population live in the global South (King, 2016), suffer from similar problems to those living in Lebanon with low quality of instruction, weakened structures, and systems (King, 2016) and uneven distribution of professionally trained teachers (UNESCO, 2019).

In the field of education, the research provides

- A continued line of inquiry around teacher agency in practice, as a sociocultural, ecological, temporal yet complex construct;
- Engagement with coding and making ICT tools which has the potential to demystify computation as a “big black box” and engage learners to deconstruct abstract concepts;
- A model that is designed to ecologically use low-cost ICT and everyday items to address problems around learners;
- A framework of innovation in learning with knowledge-building principles.

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Appendices

Appendix A: United Nations Declarations and Conventions

The landmark dates of the United Nations declarations and conventions are: (1) the Universal Declaration of Human Rights (1948) which recognises compulsory primary education as a universal entitlement; (2) the 1951 Convention related to the Status of Refugees; (3) the right to education in emergencies and (4) the right to education for refugees, migrants and asylum seekers (Dryden-Peterson, 2011).

The humanitarian approach describes UNHCR's general institutional approach to refugee education and views education as one component of a rapid response, providing immediate protection to children and preventing human rights violations. It does not frequently involve collaboration with governments or institution-building and often relies on non-profit organisations.

The human rights approach emphasises education as a human right to be realised and cultivated in any situation, including crises; it defines education as an “enabling right” providing “skills that people need to reach their full potential and to exercise their other rights, such as the right to life and health” (INEE, 2010, p. 7). Education can only fulfil this promise if it is of high quality, meaning that it is available, accessible, acceptable, and adaptable (Dryden-Peterson, 2011). This approach to education is consistent with the fundamental mandate of UNHCR but does not align with current practice, particularly in relation to quality.

The developmental approach recognises education as a long-term investment for society and the lack of quality education in crises as holding back development potential, even allowing “backward development” (Dryden-Peterson, 2011, p. 15)

Appendix B: RACE II Strategic Approach

RACE II seeks to build on RACE I, envisaging now a more strategic approach to the education sector response, on the premise of a stabilisation and development agenda through these key strategic shifts:

- Aligning with the SDGs' Goal 4 on Education, RACE II will seek to integrate human rights, child rights, and child protection principles, as key to its interventions;
- Ensuring that quality education opportunities are available for the most vulnerable children and families, whether they be non-Lebanese or Lebanese (World Bank, 2016b);
- MEHE and its partners will implement systemic and holistic interventions that address both the demand for, and the availability of, quality public education services.
- An acceleration towards ensuring that all children and youth aged 3–18 years are enrolled in quality and inclusive education opportunities. This explicitly expands the sector's responsibility to support education opportunities for all throughout their life cycle; from early childhood education, to improving quality of teaching services for primary, secondary, and vocational education, and a focus on equipping children and youth with effective life-skills. (MEHE, 2016, p. 4)

Sustainable Development Goal (SDG) 4 (<https://www.sdg4education2030.org/the-goal>). The 2030 Sustainable Development (SDG) Goals particularly, SDG 4.7 states that by 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture's contribution to sustainable development.

Appendix C: List of Literature Review Journals

Initial List of Journals

1. Journals of the British Education Research Association (BERA)
2. *Journal of Transformative Learning*
3. *Journal of Technology, Education and Pedagogy*
4. *International Journal of Teacher Education and Professional Development*
5. *Journal of Pedagogical Research*
6. *Journal of Information Technology for Teacher Education*
7. *Journal of Educational Research*
8. *Journal of Curriculum and Pedagogy*
9. *International Journal of Education Development*
10. Oxford Academic, *Journal of Refugees Studies*

The list grew substantially to include a much larger number (listed in alphabetical order)

1. *African Journal of Research in Mathematics, Science and Technology Education*
2. *British Educational Research Journal*
3. *British Journal of Educational Technology*
4. *British Journal of Sociology of Education*
5. *Cambridge Journal of Education*
6. Oxford Academic, *Refugee Survey Quarterly*
7. *Canada's Journal on Refugees*
8. *Canadian Journal of Learning Technologies*
9. *European Educational Research Journal*
10. *International Journal of Educational Research*
11. *International Journal of Inclusive Education*
12. *International Journal of Mobile and Blended Learning*

13. *International Journal of Qualitative Studies in Education*
14. *Journal of Constructivist Foundations*
15. *Journal of Education*
16. *Journal of Educational Psychology*
17. *Journal of Instructional Psychology*
18. *Journal of Learning for Development*
19. *Journal of Migrant Education*
20. *Journal of Professional Development in Education*
21. *Journal of Reflective Practice*
22. *Journal of Research in Science Teaching*
23. *Journal of Research on Technology in Education*
24. *Journal of STEM Education*
25. *Near and Middle Eastern Journal of Research in Education*
26. *TechTrends*

Appendix D: Statistical and Experimental Design TPD Focused on Achievements

All examples to various degrees show TPD aiming to introduce new practices, and seem designed to strengthen achievement rather than teachers' learning. They do not shed light on the range of sociocultural elements at play that influence teacher agency from teachers' vantage point.

- Shaha and Ellsworth (2013), Roth et al. (2011), and Allen et al. (2011) used ICT within a web-based professional development platform or at a distance but mostly conducted one-on-one teaching with higher performance and effective implementation of approaches as assessed in Shaha and Ellsworth's randomised control group. They all reveal the importance of coaching associated with classroom achievements which can be fostered by cyber collaboration. There is an effective student achievement when teachers implement in practice and reflect.
- Buczynski and Hansen (2010) describe how fourth to sixth grade teachers had the opportunity to participate in constructivist, hands-on experiences using science kits and teachers would then use them in their classrooms with students.
- Doppelt et al. (2009) also show similarities with time to practise between delivered workshops for teachers to implement activities in the classroom and to reflect and discuss them in workshops. Although similar in the sense of putting teachers in the shoes of their students, with reflection on practice, it is deeply content-based as compared to this intervention which is content and process based. On the other hand, teachers who implemented alone, that is, without models of curricula had lower student achievement than those teachers who had access to materials and expert support combined with collaborative active learning opportunities that focused heavily on sequencing and presenting.
- Heller et al. (2012) engage teachers in implementing the same activities that they learnt with their students in scientific investigations that were used in the learning experience.

- Greenleaf et al.'s (2011) TPD model supported the TPD with *reflective practice* in an approach that is collaborative through group interviews which they documented, thus incorporating reflection into the TPD model. After teachers participated in TPD activities as learners, they participated in a debrief, describing the elements of the activity associated with gains in student learning.
- Kleickmann et al. (2016) explain that modelling instructions and content knowledge is important in teacher professional development. This explains the low inclination to implement in practice which does not shed light on what drives teachers to change, since even if they are implementing, they seem to replicate models of practice such as in the maker-space example study of O'Brien et al., (2016) with teachers replicating the models used in the TPD with students in maker fair preparation.
- Johnson and Fargo's (2014) two-year PD model promoted learning over time, and engaged teachers in strategies for culturally relevant pedagogy with intensive workshops reinforced through occasional release days and monthly grade-level workshops with professional learning communities. By promoting learning over time, both within and between sessions, learning during the school year in a PD that is sustained may lead to science instruction for learners; little is said on how critical reflections are nurtured and little is known on what drives teacher agency.
- Lee et al.'s (2018) within a randomised trial, focused on the effectiveness of TPD. The case study is focused on the sense of efficacy, and changes in beliefs in a sustained professional development following Vygostkian (1978) theory adapted to the model of coaching in distance-based, instructional coaching. Although it is an in-depth case study, it is decontextualised and examines efficacy of a summer PD sustained with coaching (one-on-one) over two years (via the Internet) with a teacher Kara in a middle-school science rural setting in the US. The case study examines teacher's knowledge, self-efficacy, and the

classroom practice of a guided science inquiry instructional approach. It draws on empirical data using an in-depth analysis of a single case whose unique teaching schedule allowed for an examination of changes in science inquiry's instructional practice. As part of a randomised trial, the aim is to understand the efficacy of the TPD coaching model. The study draws on Vygotsky's (1978) space as a framework to analyse changes in Kara's beliefs and instructional practice as she engaged in the summer PD inquiry teaching practice without and with support, and in her teaching practice after the coaching ended. The process of appropriation between the four quadrants is described as Kara internalised and appropriated learning with support from coaches in one-on-one dialogues. The understanding of appropriation seems to be to implement the same instructional strategy. The study emphasises the importance of teachers needing to validate what they do prior to classroom practice and their need for content knowledge, yet adds little to the concept of teacher agency in practice and dialogic, discursive, dialectic conversation around learning. Although these TPD models show to various degrees the indicators that Darling-Hammond et al., (2017) emphasised as effective TPD with a focus on enhancing classroom experience, "student outcomes", and "student achievements" (Darling-Hammond et al., 2017, p. 25), none of them suggest that teacher agency was nurtured or that teachers were motivated as actors. In addition, they do not seem to build a sense of purpose and consistency between the professional learning experience and the wider social and educational context as suggested by Cordingley et al., 2005, p. 5).

Appendix E: Eileen Kennedy (2014), Continuous TPD Model

Kennedy grouped TPD into three categories, transmissive, malleable, and transformative, suggesting blurred boundaries within the various models such that transformative models may have characteristics of malleable TPD; for example, with lines that may permeate between them enabling the transformation of practice (Kennedy, 2014).

The eight models are grouped under three categories as follows: “transmissive” with the training, deficit, and cascade models; “malleable” with award-bearing, standards-based, and coaching/mentoring models, and “transformative” with community of practice and collaborative professional inquiry models (p. 693). They are explained hereafter.

1. The Training Model of CPD is universally recognisable (Little, 1994; Kelly & McDiarmid, 2002) and is arguably a dominant form of CPD for teachers. This model of CPD supports a skills-based, technocratic view of teaching whereby CPD provides teachers with the opportunity to update their skills to be able to demonstrate their competence. It is generally “delivered” to the teacher by an “expert”, with the agenda determined by the deliverer, and the participant placed in a passive role. While the training can take place within the institution in which the participant works, it is mostly delivered off-site and is often subject to criticism about its lack of connection to the current classroom context in which participants work.
2. The Deficit Model is designed specifically to address a perceived deficit in teacher performance. This may well be set within the context of performance management, which itself is subject to debate over its fundamental purpose.
3. The Cascade Model involves individual teachers attending “training events” and then cascading or disseminating the information to colleagues. It is commonly employed in situations where resources are limited.

4. The Award-bearing Model of CPD is one that relies on, or emphasises, the completion of award-bearing programmes of study – usually, but not exclusively, validated by universities.
5. The Standards-based Model is the “scientific” basis on which the standards movement relies heavily. It promotes a narrow perspective of learning, focusing on standards of learning of individual teachers and resultant rewards at the expense of competences. “The standards-based model of CPD creates a system of teaching and teacher education that can generate and empirically validate connections between teacher effectiveness and student learning” (Beyer, 2002, p. 243) and belittles notions of teacher agency and professional growth and the moral and value-based purpose of teaching (Beyer, 2002, p. 243).
6. The Coaching/Mentoring Model: the defining characteristic of this model is the importance of the one-to-one relationship, generally between two teachers, which is designed to support CPD. Power relationships are particularly important to examine within coaching or peer learning, to have more reciprocity in the relationships.
7. The Community of Practice Model: there is a clear relationship between communities of practice and the mutually supportive and challenging form of the coaching/mentoring model discussed above. The essential difference between the two is that a community of practice generally involves more than two people and would not necessarily rely on confidentiality.
8. The Collaborative Professional Inquiry Model refers to an orientation to professional learning and experiences that include an element of collaborative problem identification and subsequent activity, where the subsequent activity involves inquiring into one’s own practice and understanding more about other practices. Kennedy refers to Timperley et al.’s (2007) knowledge-building cycle. and Stoll et al. (2006) claim that professional

learning communities can be an effective route to enacting education reform at individual, school, and system levels.

9. Action Research Model

Kennedy continuous TPD model categories are analysed with reference to policy and Sachs' (2001) concepts of professionalism – managerial and democratic – demonstrating a delineation between transmissive and transformative TPD with boundaries that are not always delineated and lines that may permeate in between. She explains that agency must be enacted in some way to make a positive change to practice. According to Kennedy (2014), professional autonomy is only ever transformative if it is translated into agency and translated into practice and to make real progress, teachers need to have autonomy and the ability and space to exert agency.

CPD policy aspect ^a	Managerial perspective on professionalism ^b	Democratic perspective on professionalism ^c
Overall purpose	Deficit (to remedy weaknesses)	Developmental (enhancing specific strengths and interests)
Unit of focus	Individual	Collective
Teacher engagement with policy	Compliance with policy directives	Contribution to policy development and considered enactment of policy directives
Dominant underpinning perspective on teacher learning	Behaviourist (instrumental learning)	Social constructivist
Focus of learning	Development of technical, role-focused knowledge and skills	Acknowledgment and articulation of values and beliefs that inform, support or inhibit acquisition and application of knowledge and skills
Motivation	Externally imposed	Internally driven
Accountability	Measured against externally prescribed standards	Measured against context-specific and negotiated desirable outcomes

Notes: ^aFeatures of policy that can be analysed against perspectives on professionalism.

^bTeacher as a compliant, efficient worker.

^cTeacher as change agent and proactive advocate of social justice.

Table E1: Analysis of Aspects of CPD Policies against Perspectives on Professionalism
 Note. Taken from Kennedy 2014, p. 695

Example of the transformative model in Lebanon – the RELIEF initiative

The RELIEF Centre (<https://www.relief-centre.org>) aims to speed up transitions to sustainable, prosperous societies in the context of mass displacement, to improve the quality of people's lives. The project is about the prosperity of Lebanon in particular but is also part of a larger agenda for developing sustainable ways to improve the quality of life of people throughout the world. The RELIEF Centre brings Lebanese and UK institutions and expertise together to address this challenge using cutting-edge research and innovation.

The RELIEF Centre is a transdisciplinary research collaboration that focuses on one of the world's pressing challenges of the moment: how to build a prosperous and inclusive future for communities affected by mass displacement. The Centre's research focuses on how we can measure prosperity and growth in Lebanon, moving beyond indices such as gross domestic product (GDP) to include measures of wellbeing, health, employment, and education. One of the initiatives of the RELIEF centre in education is a "Co-design Methodology for Blended Teacher Professional Development in Contexts of Mass Displacement" whereby teachers in challenging contexts of mass displacement need both expert and peer support co-working with researchers in massive online open courses (MOOCs) which involve blended learning approaches for teacher professional development. They argue that one of the most effective and evidence-led approaches is to use digital technology to facilitate teachers' sharing of knowledge and skills, and their experiences of what works in their own challenging contexts.

The RELIEF Initiative project⁴ investigates a co-design research model that collects teachers' and researchers' knowledge about effective practices in EiE (Education in

⁴ Relief Initiative, <https://www.ucl.ac.uk/news/2018/apr/ucl-lebanon-project-map-out-future-refugees>

Emergencies), generalises and shares this knowledge, and then supports teachers in recontextualising it to generate local versions of practices that have been tested by other teachers. Scaled-up online and blended learning is central to this approach. They use a co-design approach that works with teachers and education leaders in local communities to elicit their experiences and expertise in providing EiE (Pherali et al., forthcoming). The classroom is conceived as a living laboratory, where teachers conduct experiments, observe problems, investigate what is needed, design solutions, and evaluate outcomes. The approach engages these teachers to help them articulate and generalise their practice for others, to identify the successes, the problems, and the changes they made. The RELIEF initiative co-designs the curriculum for a MOOC to share these practices with many more teachers working in formal or non-formal contexts.

Appendix F: Cascade Models

School-based professional development in sub-Saharan Africa (Hassler et al., 2018)

Hassler et al.'s (2018) TPD work with teachers in sub-Saharan Africa shows that school-based TPD (SbTPD) may nurture collaboration and knowledge-sharing amongst teachers forming Communities of Practices and enabling agentic action. While the intervention invites teachers from two schools to join, it nurtures collaboration between themselves and their students and communication amongst teachers across schools. Research shows that variations to the cascade model has led to teacher agency, aside from being combined with web support by combining effective strategies (Hassler et al., 2018).

Literacy Project, the Philippines

This project in the Philippines is of interest because, as opposed to all other mentioned research, it did not show significant improvement in teachers' knowledge and learning. The model reached 35,000 schools, 255 divisions, 17 regions, and 300,000 teachers through a cascaded model, training school lead teachers who train teachers and meet every two weeks, forming a learning action cell reflecting on the knowledge-building process. The small but significant gains in teacher knowledge and learning included considerable variation between schools and interestingly, rural teachers performed significantly better than urban teachers and teacher satisfaction was highly positive (Hagerman & Hagerman, 2018).

Appendix G: Examples of Technological Determinism

Cuban (2002) Study

Cuban (2002) illustrates how, in practice, teachers struggle to make use of technology regardless of whether it is integrated or not into their teaching. He argues that equipping schools with technology will not necessarily cause improvements in teaching efficiency and learning outcomes. He points out that even though access to machines was maximal, change was minimal (Cuban, 2002, p. 93) and even when new technologies were adapted, old practices were sustained. He argues that when technology does not fit the social organisation of schooling, technology use is often marginalised, and any effect is minimalised. He contends that it is a coping strategy on the part of teachers who haven't asked for, but are expected to use, a certain technology.

Games for Refugees

See <https://mashable.com/article/refugee-children-apps-education>.

This example focuses on the mobile games *Antura and the Letters* and *Feed the Monster* which both received top honours for EduApp4Syri. The goal was to leverage the widespread availability of smartphones to develop free educational alternatives for millions of Syrian children forced out of school due to conflict. However, as stressed by Unwin et al. (2017), such games for refugees reveal inconclusive evidence of enhanced learning.

Appendix H: Examples of Transformative Pedagogies with ICT

The three models that Somekh (2008) attributes as transformative harness teachers' practices and provide approaches and content that are contextually relevant for teachers and pupils (Pickering et al., 2007) and opportunities to engage in learning in and out of school ((Darling-Hammond et al., 2017; Cordingley et al., 2005). Somekh (2008) suggests that teachers' pedagogical adoption of ICT occurs in situated, social, cultural, and policy changes; and policy should reinforce classroom implementation of ICT in ways that use pedagogy that transform schooling.

The examples stress that teachers' drive to adopt ICT pedagogically, aside from being equipped with ICT, needs to focus on changing the process of learning using ICT tools which led to high-level ICT skills acquired as a spin-off from using them purposefully to find things out and create products. The examples show changes in established epistemologies of the school through the mediating effect of ICT and changing pedagogies.

ICT-Initiated Development in Godøy Lower Secondary School in Norway (Krumsvik, 2006)

The study took place in a school on Godøy Island in Norway. PILOT (Project: Innovation in Learning, Organization and Technology) was aimed at obtaining knowledge about how teachers accept and utilise technology over time and how this influences the school organisation (Krumsvik, 2006). It was conducted as action research. As in the previous example, the teachers' initial response was to focus on the negative aspects of the work which generated anxiety, leading to regular conversations between teachers and staff. They revisited and reconceived the school's epistemological and ontological practices, leading to the development of a new assessment framework. The balance of power between teachers and students shifted with teachers' expertise in textbook knowledge being challenged by information available from the Internet. Interestingly, systemic change began to take place when the teachers decided to integrate what they had learnt into the syllabus. This had an impact on the

school's structure, by leading to the second major innovation, the reorganisation of the school day.

The Enlaces ICT Initiative of the Chilean Educational Reform (Hinostroza et al., 2002)

The Enlaces ICT initiative is part of the national programme to improve the quality of education in 10,000 public schools throughout Chile. Enlaces provides ongoing technical and pedagogical support, delivered locally to each school through a partnership of the Education Ministry with 24 universities. In 1999–2002, Chile participated in the SITES M2 international qualitative study of innovative pedagogical practices using ICT. Seven schools were selected as case studies using a local definition of innovative pedagogical practice. Local criteria included flexible lesson planning, collaborative cross-curricula work using ICT, a focus on the process of learning rather than its products, increased student participation and control over their own learning, and pedagogical planning that ensured “a correspondence between the goals, the evaluation and the ‘success’ criteria” (Hinostroza et al., 2002, p. 461).

Teachers and students reported that the main impact of the Enlaces project work was on learning achievements and student motivation. Students provided many examples of becoming fascinated by learning things directly relevant to their own lives and their local community, and gaining new understanding of the relationships between knowledge in different subjects. Teachers across all the case study schools noted a marked improvement in students' motivation to learn. In terms of teaching and learning processes, students engaged. Teachers were aware that changes in their pedagogy led them to adopting new roles, particularly in “scaffolding” students' learning through assisting individuals and groups and in producing “activity guides” to provide structure for exploratory projects.

Teachers perceived that the student's role had also changed to “learning on his/her own” (Hinostroza et al., 2002, p. 467). In terms of learning achievements, Hinostroza et al. record that these new kinds of learning were not captured by national tests, which showed little change in students' attainment. They conclude: “The challenge now is to deepen the identification and

definition of these impacts and opportunities, and eventually include them as part of the national assessment tests” (Hinostroza et al., 2002, p. 468).

The Apple Classroom of Tomorrow (ACOT) Project in the USA (Sandholtz & Ringstaff, 1996)

Sandholtz and Ringstaff (1996) describe and analyse the process of teacher change, and record that the introduction of technology brought teachers into conflict with their existing pedagogical beliefs, changing their relationships with their students, reducing their apparent “control”, and making their classrooms noisier. At first, they responded by imposing restrictions on students’ use of technology, but over time, they learnt new ways of working that turned technology to pedagogic advantage. Although the process was slow, it led to noticeable shifts in teachers’ roles and the development of new practices. As radical pedagogic change developed, student motivation increased, and teachers developed new ways of assessing their learning that made creative use of technology. However, in relation to preparing students for standardised tests in traditional paper-based environments, teachers continued to have serious concerns and to struggle.

Appendix I: Shift in Teachers' Belief in Knowledge-Building Processes and Previous Work

Knowledge-building models of learning require a change of teachers' perspectives and beliefs about education, content, and learners, to venture into knowledge-building around emergent problems. Drawing on experience, these notions are outlined to describe the shift of perspectives and beliefs during the knowledge-building process between content delivery and a problem-orientated, ICT-enhanced mode.

Table I1

Shifts in Teachers' Perspectives and Beliefs Around Pedagogy and ICTs Between Content Delivery and Problem-Orientated, ICT-Enhanced Learning

Teachers' shifts in perspectives and beliefs	
Content delivery	Problem-orientated ICT-enhanced
Teachers should deliver content	Learners should be actively engaged in constructing their learning through scientific inquiry.
Learning objectives are taught before making it relevant to students' lifeworld	Learning goals become relevant to students when they are connected to students' lifeworld
Students learn better individually	Students learn better collaboratively
Science is static and all science problems have yes/no answers	Science is dynamic and real-life scientific problems are open-ended
Learners need to first understand concepts to use them in real-life situations	Learners need to make meaning in situ and understand concepts (Vygotsky, 1978)
Teachers should make all choices around learning (authoritarian, teacher-led)	Teachers should engage learners in a participatory process and discuss choices around learning
Knowledge resides in people's minds	Knowledge is collaboratively constructed by engaging with concepts around real-life issues
Learning should be confined to the boundaries of the classroom	Learning takes place in real-life all the time and extends into the community
Students do not have the capacity to	Students have capacity to solve scientific problems

solve scientific problems if they are not given specific instructions	when guided within scientific parameters
Teachers need to learn how to use ICT and implement it in their teaching	Teachers are exposed to ICT, tinker with it, explore its affordances, and select which is needed
Teachers are asked to use a specific ICT for teaching	Teachers are encouraged to use ICTs that they know and already use in their daily lives
Learners complete and end a project	Projects are owned and made by learners who sustain them past completion of the project
Knowledge accumulates and knowing content is a goal in itself	Advancing knowledge is the goal (Scardamalia and Bereiter, 2005)

Overview of Previous Work

1. The first iEARN (International Education and Resource Network) online courses (2001), which focused on using technology to integrate online collaborative projects in the classroom and reached over 4,000 teachers around the world: online teacher training to integrate collaborative web-based projects in the classroom.
2. The Global Teenager Project (2005, <https://globalteenager.org>), Coordinators' Professional Development Course.
3. Global Educators (2006, <http://globaleducator2011.pbworks.com/w/page/33858687/FrontPage>) Online course co-developed in partnership with Wageningen University, Education for Competences, The Netherlands.
4. Douroub (2010–2014, <http://douroublibrary.pbworks.com/w/page/27432840/FrontPage>) a three-tier e-learning professional development programme for Yemeni educators developed with the Yemeni Social Fund for Development and funded by the World Bank. The programme was interrupted because of the war.
5. The I-DO, (2010-2011, <http://idowikis.pbworks.com/w/page/41124543/FrontPage>) is most relevant because it was addressed to Lebanese science teachers and entailed working with

23 Lebanese schools to build teachers' capacity to develop classroom-generated media such as videos, blogs, and wikis; It involved science teachers in learning how to design real-life scientific experimental research with their students to ultimately create classroom-generated content. The project was implemented in close collaboration with the Ministry of Education and Higher Education.

6. The Raspberry Pi for Learning, (2014-2015, <https://www.raspberrypi.org/learn/>; Pi4L reports. 2014–2015, available upon request). Helping teachers to reintegrate refugees and at-risk youth into learning, Pi4L is a non-formal e-learning programme that provides access to quality education to refugees, at-risk youth, and underserved communities at large. It expands the capacity of educators to provide quality learning to a larger number of children. It also mentors teachers to facilitate the successful integration of children into mainstream schooling. Specifically, it comprises an intensive teacher-training programme followed by delivery of a short six-week education programme to children aged 8–15 using ICT, namely Raspberry Pi computer labs, to teach basic numeracy, computer coding, and personal/social skills in the context of a pedagogical approach, which encourages positive interactions, teamwork, and autonomous learning.

The programme is designed to be run in partnership with delivery agencies, whose wider curricular programmes it enhances; it can also be run independently, as a valuable programme. The programme integrates life-skills, social and health awareness themes (UNICEF's hygiene, Polio, HIV-AIDS, relationships, and safety themes, <https://www.unicef.org/innovation/stories/inexpensive-screens-raspberry-pi>). Although the programme is built around the use of technology (Raspberry Pi computers and peripherals, Scratch coding software, Scratched education (<https://scratched.gse.harvard.edu/>), and KA Lite numeracy programmes), it is not primarily about the technology. It is best conceived as a pedagogical programme, which uses technology and e-learning techniques to develop children's skills, motivation, joy of learning, and autonomy as learners. As such, it requires

teachers themselves to learn new skills to incorporate into their teaching the interactive and motivating approaches that are so important in the lives of refugee children. This means that integral to the Pi4L programme is an intensive teacher-training module with follow-up coaching and mentoring for the teachers involved.

Pi4L was piloted in two phases, with four implementing non-governmental organisations (NGOs). The partners were located in Beirut (Mouvement Social MS), Tyre (Ana Aqra), Nabatieh (AVSI), and Zahle (Beyond). All four organisations are UNICEF partners and have years of experience in non-formal education. They have solid administrative structures and assigned Pi4L coordinators and teachers, recruiting students to participate in the Pi4L Pilot. Each partner ran two classes per day in phase 1 and phase 2 of the pilot programme. The first phase of the pilot programme (August–November 2014) reached 158 Syrian refugee children, with an average of 50% girls. The second phase (December 2014–April 2015) reached 146 children, of whom 65% were girls.

7. Digital Learning Innovation I, IDRC Grant (External Evaluation Attached)

Appendix J: Relationships Emphasised in the Coder-Maker Intervention

Table J1

Relationships Emphasised in the Coder-Maker Intervention

Relationships table			
Level	Theory	Who	What do teachers do?
Inter	Socioconstructivist (Vygotsky, 1978) Transformative Learning Theory (Mezirow, 2000) Communicative Action (Habermas, 1985)	Teacher	Teachers' internal thinking, intersubjectivity, perceptions, reflections around practices throughout the process around lifeworld, world perspectives, and how they are mitigating challenges
Intra	Socioconstructivist (Vygotsky, 1978) Social Learning (CoP- Lave & Wenger, 1991) Conversational Theory (Laurillard, 2002)	Teachers– Teachers	Teachers from the same school learn, collaborate, and discuss learning with teachers from different schools during face-to-face intervention – teachers communicate between interventions using WhatsApp group messaging and IEA online platform. Teachers collaborate with other teachers at school, during workshops and working sessions, and in-between interpersonal meetings.
	Situated Socioconstruction of Knowledge (Scardamalia & Bereiter, 2005) Social learning (CoP- Lave & Wenger, 1991)	Teachers– Technology	Teachers learn how to use technology in situ to design learning for their students. They can engage with technology, to tinker and use it to engage with physical objects in the world. Technologies are taught in context and teachers use what they need, explore, and engage with technology, depending on the problem situation they select. They relate the concepts in the problem to learning goals.

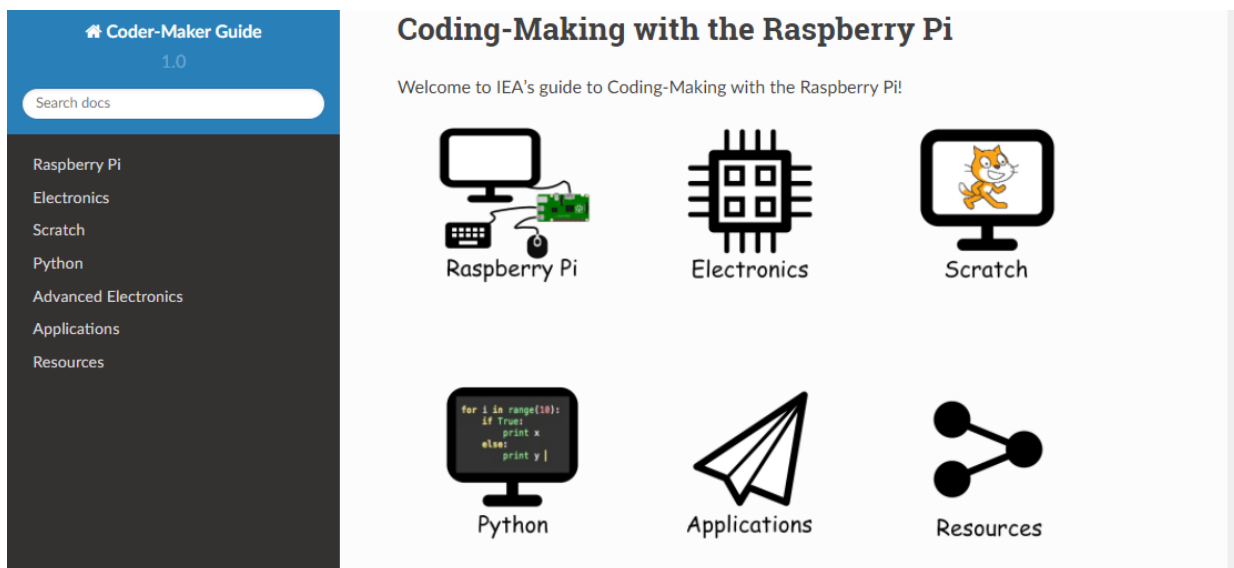
			They learn individually and collaboratively with other teachers from the same school and across schools during interpersonal meetings.
	Situated Socioconstruction of Knowledge (Scardamalia & Bereiter, 2005; Brown & al., 1989)	Teachers– Students	Teachers negotiate problems with students as they apply learning in practice and address a problem. Teachers communicate face-to-face with students in the classrooms and working sessions. Communication extends after class using WhatsApp group messaging.
	Socioconstructivist Vygotsky (1978) Social learning (CoP- Lave & Wenger, 1991)	Teachers– Principal	Teachers justify and negotiate project work with their school principal.
		Teachers– students	Teachers and students negotiate projects.
		Teachers– Parents	Teachers communicate with parents to ensure that their children have permission to engage in project work.
		Teachers– Mentors– Facilitators	Teachers discuss with the intervention facilitators and mentors.

Appendix K: List of Applications

The applications are downloaded on the RPi SD cards and are in the repository online on IEA's website. Figure K1 shows the initial version 1.0 used during this research.

Figure K1

Screenshot of the Guide with Tutorials and Applications



Applications that use the Scratch software

1. Automated Garage Door
2. Automated Home System
3. Baby Safety Monitor
4. LED Clock
5. Moisture Monitor
6. Photosynthesis Bulb
7. Schools Safety Sign
8. Security System

Applications that use the Python software

1. Accelerometer
2. Anemometer
3. Buster
4. Circulatory System
5. Distance Tracker
6. Home Automation
7. Paper Plane Launcher
8. Path Finder
9. Rate of Reactions
10. Remote Controlled Car
11. Robotic Arm
12. Smart Fan
13. Smart Garage
14. Smart Greenhouse
15. The Buoyant Device
16. The Flying Propeller
17. Traffic System
18. Vibrating Creature
19. Walking Creature
20. Weather Station

Appendix L: Teacher Workshop Objectives

Teachers who participate in the intervention will gain, develop, enhance, acquire, and apply the following:

Knowledge gained:

- Introductory principles and ICT affordances
- Visual block programming (using Scratch)
- Object-orientated programming (using Python)
- Usage of electronic material and circuitry in teaching
- Methods to engage students in open-ended challenges and learning-centred processes

Understanding developed:

- Purpose, how it relates to learning objectives and to the world around them
- Principles of programming
- Learner-centred methodologies, dialogue, conversations, role play, reflections, open-ended questions, and project design
- Scratch and Python games and applications depending on students' level

Skills acquired and applied:

- Design projects around student-centred methodologies
- Foster independent learning in their classrooms
- Have students code basic applications using Python and Scratch
- Engage students in open-ended challenges
- Engage students in knowledge-building and designs to create applications
- Engage and guide their students to learn, apply, and create new applications
- Engage their students in expressing themselves (including their use of various media)
- Engage their students in adapting or creating their own applications in the form of purposeful and meaningful prototypes or virtual games and applications

- Promote collaboration amongst students
- Be able to make use of digital learning
- Enhance their pedagogical skills
- Develop a greater ability to work in small teams
- Have a higher respect for the capacity and development of their students
- Give more space for students to engage in authentic learning
- Value the contribution of each individual child
- Be able to connect learning in and outside of the classroom with students' interests

Attitudes established in the educators' own classrooms:

- Awareness about ICT and their affordances and open-ended challenges
- Make use of technology to address problems
- Independent and autonomous learning
- Encourage sharing and peer collaboration amongst students
- Ignite curiosity and eagerness to learn

Benefits accrued in the educators' normal work:

- Educators will exert agency in practice and acquire new methods in teaching

Appendix M: List of Projects Presented at MEHE

Project name	Description	School	Team
Detector of two persons in a toilet cabin	A system that detects two persons in a toilet cabin and operates an alarm at the school's admin to protect children from sexual harassment	Jbeil Second Public Middle School	4 Syrian males 0 Syrian females 1 Lebanese male 2 Lebanese females
Auto-bell	Automatic bell that operates according to the school's schedule and holidays. The school has three floors and one supervisor.	Baakline Intermediate Official School	1 Syrian male 0 Syrian females 3 Lebanese males 2 Lebanese females
Blind aid stick	A stick that warns blind people about the presence of hurdles in their way through sounds that the stick emits	Institut Technique de Batroun	0 Syrian males 0 Syrian females 3 Lebanese males 0 Lebanese females
Electro power station	A clean power station that uses the Raspberry Pi	Jahlieh Public Middle School	2 Syrian males 0 Syrian females 3 Lebanese males 0 Lebanese females
Septic tank alarm system	An alarm system that warns about the increase of water level in a septic tank	Yahshoush Mixed Public Middle School	5 Syrian males 0 Syrian females 13 Lebanese males 0 Lebanese females
Medical room	A room that provides medical support at home	Martyr Rafic Hariri Secondary School, Doha Choueifat	1 Syrian male 1 Syrian female 2 Lebanese males 2 Lebanese females
Door opening system	A system that opens doors automatically for disabled people in public spaces such as supermarkets, hotels, and restaurants	Hoch El Omara Secondary Public School, Bekaa	1 Syrian male 0 Syrian females 3 Lebanese males

			2 Lebanese females
Raising awareness about nature's cleanliness	A digital story to raise awareness about the importance of keeping our environment clean	Kfarmatta Public Middle School	0 Syrian males 1 Syrian female 1 Lebanese male 0 Lebanese females
Animal protection system from cars	A system that protects animals and operates on the Raspberry Pi	Hammana Public School	0 Syrian males 0 Syrian females 3 Lebanese males 4 Lebanese females
Robot vacuum cleaner	The robot vacuum cleaner is a fully automated self-operated device for school yards that runs on the Raspberry Pi and is programmed using Python	Antelias Public High School	0 Syrian males 0 Syrian females 4 Lebanese males 0 Lebanese females
Protection of children in public gardens	An alarm system that warns the operators of a public garden if children approach the fence. It operates a light and an alarm.	Beirut Al Aliah Public Middle School for Girls	2 Syrian males 2 Syrian females 2 Lebanese males 2 Lebanese females

Appendix N: Credibility, Dependability, Conformability, Transferability

Credibility

Lincoln and Guba (1987) argue that ensuring credibility is one of the most important factors to establish trustworthiness and can be attained by:

(a) using well-established and proven research methods: indeed, the research methods used, interviews, observations, and participants' reflections are well-established methods.

Furthermore, credibility is heightened with triangulation of data and its cross-reference in the interrelationship between agency, structures, and cultural practices;

(b) developing familiarity with the institutional culture and participants: following Lincoln and Guba's (1987) recommendation, I spent considerable time in the field which helped me to gain trust and develop a deep understanding of the issues that participants are facing in their institutions. I also consider myself an "insider" as I am Lebanese with knowledge of Lebanon's public school culture, have a teaching background, and relate deeply to teachers.

Relating to teachers, yet being the programme director, I was conscious of the importance of creating an environment that is reciprocal" as well as establishing a good rapport with participants (Spradley, 1979). This was possible early in the intervention as I attended events regularly, including all workshops, working sessions, the Sharing Day, and the competition. During these events, the conversations produced data generated spontaneously, as compared to data generated from questions during the interviews, thus enriching deeply the information gathered about participants' behaviour. These unsolicited accounts, as argued by Becker and Geer (1960) contributed to ensure that the data generated about the participants perspectives were not entirely reliant on the interest of the researcher to solicit answers (Becker and Geer, 1960).

These frequent conversations during those events, outside their schools, provided a natural setting where they were learning and avoided participants reacting to what they thought the researcher wanted to hear (Becker and Geer, 1960). During those sessions, I presented

myself as a learner (Wax, 1960), frequently related to my experience as a teacher, listened actively, and always “dressed down” simply to look similar to teachers (Fontana & Frey, 1994 p.367);

c) random sampling, which is not met, per se, in this research since sampling is purposive to ensure that the selection of schools includes those with the highest number of refugees and that the data collected unravels the issues in the phenomena. However, since the initial sample of schools and participants were proposed by the Ministry of Education, I would argue that it negates potential charges of bias in the selection of the sample. Furthermore, I stress the opposing case to highlight the differences between perspectives and opinions of the group, thus exhibiting characteristics of similarity or dissimilarity, to gain greater knowledge about the assumptions and theories that underpin the research.

Dependability

Lincoln and Guba (1987) explain that dependability involves the use of overlapping methods an in-depth methodological description in order to allow the research to be repeated (Lincoln and Guba, 1987). Positivist researchers may use standardised techniques to ensure that repeating the research with the same methods will yield similar results. However, it is argued that the same techniques will undoubtedly vary among people and across contexts, which undermines the value of standardised research methods (Lincoln and Guba, 1987).

Furthermore, Lincoln and Guba (1987) argue that dependability has close ties with credibility and may be achieved using overlapping methods. which I argue is met in this research by applying the methods rigorously. In addition, they propose that research reports provide a detailed account of the research process, enabling readers to gauge the extent to which suitable research practices have been respected and to repeat the same process should they wish to. Similarly, Hammersley and Atkinson (2007) maintain that dependability lies in how effectively we can understand an account and its context – the presuppositions on which it relies, how it was produced, by who, for whom, and why – the better able we

are to anticipate the ways in which it may suffer from biases of one kind or another as a source of information. (Hammersley & Atkinson, 2007, p. 98)

Following their advice, I provided (a) a detailed account of the intervention and its planning; (b) the research design and its implementation; (c) how the data was gathered and documented during fieldwork; (d) a reflection of the account discussing and analysing the process of inquiry undertaken.

Conformability

According to Lincoln and Guba (1987), conformability includes triangulation to reduce effect of investigator bias, admission of the researcher's beliefs and assumptions, recognition of shortcomings in the research methods and their potential effects, and in-depth methodological description to allow integrity of research results to be scrutinised (Lincoln and Guba, 1987). "Triangulations means checking of inferences drawn from one set of data sources by collecting data from others" (Hammersley & Atkinson, 2007 p. 184).

Triangulation is about approaching data with multiple perspectives and hypotheses in mind (Denzin & Lincoln, 2011). It is "an attempt to relate different sorts of data in such a way as to counteract various possible threats to the validity of the analysis" (Hammersley & Atkinson, 2007, p.184). I was particularly attentive to this and continuously collected data from trainers and volunteers and compared this to my notes. In addition, I built on several techniques to have a basis for checking interpretations; those included: (a) comparing the data relating to the same phenomenon but deriving from different phases of the fieldwork, checking that participants' reflections tally and are coherent with the data from the observations and interviews; (b) assessing the validity of inferences between concepts and examining data relating to the same concept from participant observation, interviewing, reflections, and so forth; (c) by checking the links between concepts and indicators by recourse to other indicators; (d) regular debriefing at the end of face-to-face sessions with trainers and volunteers; (e) discussing and checking interpretations with participants throughout the process.

Transferability

According to Lincoln and Guba (1987), transferability refers to the extent that the research can be applied in another context. This does not mean that the research findings would be the same but that applying the same intervention in another context is possible. Thus, it is important to note that transferability does not mean generalisation. Unlike generalisation, transferability does not claim broad or general truth, but it allows the reader to make connections between the elements of the research and to make associations that may be relevant in their own context. Lincoln and Guba stress that in such a case it is important for the research to give enough descriptive data to allow the reader to evaluate its applicability in other contexts. I was particularly attentive to the reliability of the details and ensured that all observations were conducted in the same place. At the same time, I initiated a conversation with the trainers and volunteers to discuss those details and created a file which had substantial descriptive elements of the intervention in the various locations. As a result, I had a thick description of the intervention which is deemed reliable.

Appendix O: Progression of Themes

Organisation of Themes

Table O1 shows the first tabulation of themes as they appeared with the number of occurrences and their source.

Table O1

Organisation of Themes

Category	Number of occurrences	Theme1	Number of occurrences	Number of sources	Theme2	Number of occurrences	Number of sources	Theme3	Number of occurrences	Number of sources
population	23	low self-esteem	12	4	problems	7	2	low aspiration	4	2
adaptation	29	culture	9	5	language	15	6	lost years	5	6
behaviour	35	language	10	5	violence	13	5	levels	12	4
relevance	46	curriculum	16	4	lack of skills	12	5	lack of interests	18	4
empowerment	23	bureaucracy	12	3	decisions	6	2	risks	5	4
lack of motivation	35	low quality	15	3	low retention	7	5		13	5
benefits	39	interactive	10	2	attractive	29	6			
challenges	31	capacities	12	2	exams	7	2	teacher status	12	2
challenges	43	equal access	8	2	time	23	5	curriculum	12	3
teacher PD	15	repetitive	4	1	relevance	9	1	accountability	2	1
positive	31	enjoyable	15	4	beneficial	16	4			
interesting	43	relevant	23	4	curiosity	18	3	learning alone	8	1
relationships	38	group dynamics	12	4	communication	23	5	school is one	3	2
teaching and learning	51	real-life problems	28	5	learning from failures	15	5	achievements	8	2
social good	31	perspectives	8	3	help others	17	4	empathy	6	2
understanding	36	conceptualise	18	4	subject	12	3	interested	15	4
social	36	knowledge sharing	12	5	learn with others	18	4	feel safe	6	5
experiential	34	mimic	12	5	assimilate	10	4	connect concepts	12	4
lifeworld	30	me, world, social	12	3	finding self, sharing	8	3	observe	10	4

learners' behaviour	36	motivated	21	4	no arguments	10	8	reliable	5	2
benefits	28	critical thinking	13	5	motivation	13	3	feeling new	2	3
complexity	32	interconnected	16	4	fear	8	4	self-confidence	18	6
challenges faced	56	open-ended	6	3	more knowledge	12	3	time	12	3
challenges faced		transportation	6	2	teacher status	10	2	practice	10	5
mitigate challenges	43	leadership support	10	2	trainers support	10	2			
mitigate challenges		interested	9	4	changes in ss relation to learning	14	4			
tasks management	26	responsible	8	2	organised	6	2	rely on each other	12	2
social good	34	solve a social problem	12	3	contribute to society	6	4	help others	16	3
project meaning	37	able to solve difficult problem	6	5	everything	15	3	part of future	9	4
character	64	perseverance	38	5	able to face future problem	14	4	self-confidence	26	5
enhanced relationships	42	learning with others	20	5	sharing	6	2	listening to others	12	2
motivated to learn	37	understand better	12		learning from failures	16	5	better grades	6	2
enhanced skills	47	creativity	23	5	collaboration	16	5	communication	4	2
computational thinking	35	logic	15		understand code	12		hypothesise	8	
understanding	24	physics	12	5	science	8		lessons	4	2
Deeper learning	22	online course	3	2	more skills	15	3	provide guiding manual	4	2
Endorsement	38	endorsement by policy makers	20	2	integration in school	18	2			
More training	18	time to practice	16	5	more working sessions	10	2			

Revision of Themes

The themes were reviewed and referenced to the guiding analytical framework: agency, cultural practices, and structures. The abbreviations used are Agency (A), Cultural Practices (CP), and Structures (S).

Table O2

Revision of Themes

Overarching themes	Sub-themes	Category	Number of occurrences	Link with analytical framework	Theme 1	Theme 1		Theme 2	Theme 2		Theme 3	Theme 3	
						Number of occurrences	Number of sources		Number of occurrences	Number of sources		Number of occurrences	Number of sources
The Context													
		population	23	A	low self-esteem	12	4	problems	7	2	low aspiration	4	2
		adaptation	29	CP	culture	9	5	language	15	6	lost years	5	6
		behaviour	35	CP/S	language	10	5	violence	13	5	levels	12	4
		relevance	46	CP/S	curriculum	16	4	lack of skills	12	5	lack of interests	18	4
		empowerment	23	CP/S	bureaucracy	12	3	decisions	6	2	risks	5	4
		lack of motivation	35	CP/S	low quality	15	3	low retention	7	5		13	5
		benefits	39	CP/S	interactive	10	2	attractive	29	6			
		challenges	31	CP/S	capacities	12	2	exams	7	2	teacher status	12	2
		challenges	43	CP/S	equal access	8	2	time	23	5	curriculum	12	3
		teacher PD	15	S	repetitive	4	1	relevance	9	1	accountability	2	1
The TPD													
		positive	31	CP	enjoyable	15	4	beneficial	16	4			
		interesting	43	CP	relevant	23	4	curiosity	18	3	learning alone	8	1
		relationships	38	CP	group dynamics	12	4	communication	23	5	school is one	3	2
		teaching and learning	51	CP	real-life problems	28	5	learning from failures	15	5	achievements	8	2
		social good	31	CP	doing good	8	3	help others	17	4	empathy	6	2
		understanding	36	CP	conceptualis e	18	4	subject	12	3	interested	15	4

Appendix P: Consent Form

The consent form was sent via email by IEA with a leaflet introducing the projects and its goals in Arabic sent by the Ministry of Education to schools.

Figure P1 Participant Consent Form

<p>نموذج موافقة المشارك في المشروع مشروع إبتكارات التعلم الرقمي أب ٢٠١٦ - ٢٠١٨ برعاية وزارة التربية والتعليم العالي بتمويل من المركز الكندي لبحوث التنمية الدولية تنفيذ الجمعية التربوية الدولية بالشراكة مع مؤسسة مكي بستر بحث دكتوراه للسيدة إيلان متني في معهد التربية، جامعة لندن</p>		<p>Participant Consent Form Digital Learning Innovations Project August 2016 to January 2018 Under the Patronage of the Ministry of Education and Higher Education Funded by the International Development Research Centre, Canada Implemented by the International Education Association In Partnership with <u>Fondation Mouna Bustros</u> Doctoral Research of Mrs. Eliane Metni at UCL Institute of Education, London</p>	
<p>إذا كان لا مانع لديك من المشاركة، يرجى ملء نموذج الموافقة هذا</p>	<p>لا No</p>	<p>نعم Yes</p>	<p>If you are happy to participate, please complete this consent form,</p>
<p>لقد قرأت نشرة المعلومات حول البرنامج وفهمتها</p>	<input type="checkbox"/>	<input type="checkbox"/>	<p>I have read and understood the information leaflet about the project</p>
<p>أوافق على إجراء مقابلات، وملء الاستبيانات ذات الصلة</p>	<input type="checkbox"/>	<input type="checkbox"/>	<p>I agree to be interviewed, fill in related questionnaires,</p>
<p>أوافق أن اعمل مع طلابي بحضور ممثلين عن المشروع</p>	<input type="checkbox"/>	<input type="checkbox"/>	<p>I agree to be observed while working with my students</p>
<p>لا مانع لدي أن تسجل مقابلي بالصوت والصورة</p>	<input type="checkbox"/>	<input type="checkbox"/>	<p>I am happy for my interview to be video/audio recorded</p>
<p>وأنا أفهم أنه إذا تم استخدام أية من كلماتي في التقارير أو العروض فإنها سوف تبقى مجهولة المصدر ولن تسب لي</p>	<input type="checkbox"/>	<input type="checkbox"/>	<p>I understand that if any of my words are used in reports or presentations they will kept anonymous and will not be attributed to me</p>
<p>وأنا أفهم أنني أستطيع الانسحاب من البحث في أي وقت، وأنه إذا اخترت القيام بذلك، فإن أي بيانات ساهمت بها لن تستخدم</p>	<input type="checkbox"/>	<input type="checkbox"/>	<p>I understand that I can withdraw from the research at any time, and that if I choose to do this, any data I have contributed will not be used</p>
<p>أدرك أنه بإمكانني الاتصال بالسيدة إيلان متني في أي وقت</p>	<input type="checkbox"/>	<input type="checkbox"/>	<p>I understand that I can contact Mrs. Eliane Metni at any time</p>
<p>الإسم</p>	<p>Name</p>		
<p>التوقيع</p>	<p>Signature</p>		
<p>التاريخ</p>	<p>Date</p>		

Appendix Q: List of Attachments

Attachments

1. Pi4L, External Evaluation, College of Teachers (Hawker, 2015)
2. DIL, External Evaluation (Tawil, 2018)
3. IDRC, Synthesis of Research (Hagerman & Hagerman, 2018)
4. Examples of a learning design prepared with teachers after the completion of the two-year process (Greenhouse Application, Teachers' Handbook: Help the growth of flora in your local environment)
5. Link to applications made available offline on the Raspberry Pi, URL retrieved 13 September, 2021, <https://iea.org.lb/CMGuide/>

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