(Un)Balanced Conversations: Participatory Action Research in Technology Development in Peruvian Primary Schools

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1 Introduction

Scholars have argued that information and communication technologies (ICTs) offer many benefits for educational systems (Alexander 1999; Charoula and Nicos 2004, 2009; Wang 2002). These include innovative instruction (Becker 1991), enhanced access to educational materials that allows for the reformulation of teaching through more flexible and interactive methods (Yavuz and Coskun 2008) and facilitation of communication between stakeholders (Sprague 1995). ICTs have been increasingly recognized as catalysts in improving education in developing countries (Cristia et al. 2012), with significant efforts being channelled towards development of educational applications for classrooms with the goal of targeting marginalized populations (infoDev 2010). The belief is that educational systems are instrumental in expanding capabilities and empowering individuals economically, socially and psychologically (Khan and Ghadially 2009).

It is often expected that the introduction of new technologies in schools would necessarily result in better educational outcomes among students. It is further argued that technological applications, when implemented with due consideration for

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unique pedagogical practices along with the constraints and motivations of specific agents, such as teachers (Martínez and Olivera 2012), "amplifies the pedagogical capacity of educational systems" (Toyama 2011: p. 1). However, there is a tendency to concentrate either on the technological inputs or educational outcomes without necessarily understanding how the space where innovations are being introduced is functioning and evolving around the expectations of various stakeholders in the process. The same is true for the development of educational software where cultural assumptions that embody application design and subsequently impact institutional use of the applications are often overlooked in the equation (McIntyre et al. 2007).

In the education domain, this has meant that elements like school management, teachers' beliefs and power relations between the different actors are overlooked (Hosman 2010; Mercer 2005). The introduction of ICTs has the potential to alter the workings of the institutions and the relationships between actors at different levels (Gobbo and Girardi 2002; Lim and Khine 2006).

Within schools, the role of teachers is crucial for ICT tools to achieve positive impacts on students (Wang 2002). To be successful in computer use and integration, teachers need "to engage in conceptual change regarding their beliefs about the nature of learning, the role of the student, and their role as teacher" (Niederhauser et al. 1999: p. 157). Reaping the potential benefits of a technology-enabled teaching environment requires a shift in the learning and teaching paradigm, including recognizing the inordinate role teachers play in this process (Afshari et al. 2009). Indeed, learning with educational applications has been proven to be more effective when used in the presence and guidance of teachers (Rouet and Puustinen 2009).

Within the realm of ICTs for educational improvement in developing countries, the focus of analysis and impact has largely been on the educational attainment of students (Habgood and Ainsworth 2011; Wood et al. 2010). Impact of ICT in education programmes has rarely been conceptualized at the level of teacher attitudes, capabilities and practices (Drent and Meelissen 2008; Judson 2006; Yavuz and Coskun 2008). The study attempts to fill this gap by identifying teachers' expectations not only in technology usage but also in software interface and interaction design.

2 Barriers to Technology Integration by Teachers

Ertmer et al. (1999) offer a conceptual basis to understand the barriers to technology introduction at the level of teachers. Building upon earlier work (Brickner 1995; Cuban 1993; Fullan and Stiegelbauer 1991), they propose that there are external (first-order) and internal (second-order) barriers to the successful incorporation of technology into educational curricula by teachers. First-order barriers focus on practical impediments to effectiveness and efficiency, while second-order barriers pertain to fundamental beliefs, such as attitudes towards engrained and novel practices, and the capacity for change of stakeholders such as teachers.

Within the developmental context for technology projects, first-order barriers have been recognized as basic economic, sociocultural, infrastructural and techno-

logical issues (Chib et al. 2008; United Nations for Development Programme 2005). Much of this analysis has focused on availability of hardware, financial resources, physical infrastructure, training sessions, etc. However, the debate has largely moved on from that of access and adoption of technological inputs to their effective appropriation and translation into educational objectives. In this chapter, we focus on teachers as key stakeholders, whose interests and needs need to be understood in order to achieve viable, sustainable and coherent impact (Ale and Chib 2011; European Commission 2001). It is important to understand the specific characteristics unique to this important stakeholder community, such as perceptions and practices concerning technological resources (Hollow and Masperi 2009; Misuraca et al. 2011) as second-order barriers to successful integration of technology into the educational milieu.

3 Attitudinal Barriers of Teachers

Successful implementation of technological resources in education has relied on teachers' attitudes towards ICT (Buabeng-Andoh 2012; Hismanoğlu 2011; Khan et al. 2012), which are expected to predict their uses of technology (Bai and Ertmer 2008). In the same sense, Cavas et al. (2009) claim that "during the process of combining ICT with education, teachers' attitude(s) towards using knowledge besides their talent and desire will be a crucial point affecting the results of application" (p. 21). On the other hand, Snoeyink and Ertmer (2001) and Buabeng-Andoh (2012) find that positive attitudes of teachers towards ICTs were related to perceptions of usefulness to the teaching and learning processes.

Khan et al. (2012) claim that "less technologically capable teachers who possess positive attitudes towards ICT, require less effort and encouragement to learn the skills necessary for the implementation of ICT in their design activities into the classroom" (p. 71). From these reflections, we consider attitude a key factor for ICT integration in education. In order to provide further granularity to the all-encompassing attitudinal factor, we next conceptualize teacher attitudes as competence, confidence and capacity for change.

Pelgrum (2001) suggests that competence is related to skills and knowledge about ICTs, while Rychen and Salganik (2003) claim that it involves not only resources of a component but also the ability to mobilize these resources appropriately in complex learning situations. While teacher training as a response to a first-order barrier of inadequate competencies has been identified as crucial (Kirkwood et al. 2000), teachers have sometimes been unable to convert this information into effective teaching practices in classrooms (Goktas et al. 2009).

Teachers' lack of confidence is revealed by an anxiety to adopt and incorporate technology in classes and the fear of encountering situations where they noticeably display a lack of proficiency in the technology use, hence significantly undermining their authority as experts in the classrooms (Guha 2000; Larner and Timberlake 1995; Olivera 2012). Peralta and Costa (2007) find that control of the technology usage is an important factor in determining their self-efficacy. Likewise, we note

that these attitudinal measures can be interlinked. Teachers consider competence a key factor to increase confidence in technology use (Peralta and Costa 2007).

The capacity for change is related to the ability to adopt, and adapt to, new teaching environments and practices (Abdullah 2009; Balanskat et al. 2006; BECTA 2004; Buabeng-Andoh 2012). Levin and Wadmany (2008) maintain that strongly held pedagogical beliefs and practices would deter the adoption of a novel technological approach. Gomes (2005) points out that integration of ICTs in education implies the advancement of new pedagogical strategies that teachers could render ineffective. Integration of computers in education by teachers is a complex process and implies learning new roles (Van den Akker et al. 1992) that usually generate a resistance in teachers because they have to leave old ones.

4 Institutional Impediments to Addressing Attitudinal Barriers of Teachers

Teachers are one key stakeholder among many within the context of an ICT in education (ICTE) project implementation; the others constituting government officials, school administrators, technology developers, students and parents, and often the implementing agency or researchers or both as the change agency. Each of these actors may have different perceptions and opinions about the role of ICTs in teaching and learning. We argue that recognizing dynamic interests of special stakeholder groups in practice would not only influence impact but may in fact constitute an impact in itself. Thus, addressing teacher attitudes, in terms of competencies, confidence and capacity for change, as deeply engrained internalized values could be understood as meaningful to the impact of a project.

The inclusion of teacher empowerment and agency as a potential positive outcome of an ICTE project has a basis in the capabilities approach (Sen 1985). This in itself is a radical departure from the individual blame bias (Rogers 2003) that has often held teachers as individuals responsible for project failure, rather than recognizing the success or failure of the system or the innovation. In other words, stakeholders (technology developers, change agencies) involved in the management of an innovation have tended to hold users (teachers) responsible for lack of project success rather than the innovation itself or the system of which these users are part of. When stakeholders involved in the management of ICT initiatives are cognizant of the limitations of a beneficiary group, in terms of their knowledge capabilities or attitudes towards adopting a technology, it could either work for or against the eventual impact of the initiative (Armstrong et al. 2005).

The identification of teachers' capabilities and values as key to the success or failure of ICTE implementation often fails to ascribe a role to teachers in the design of the technology. We hope to understand the point of view of individual adopters, or the community of teachers as users, by identifying their attitudes towards an innovation alongside the unique problems and needs they encounter. This study maintains that addressing barriers would not only build teachers' capacities needed to support

local infrastructure but also equip them to be better involved in the development of educational applications used for teaching and learning. The design of educational applications is often left to software developers who get limited interaction or feedback from the actual users of the application (Buzhardt and Heitzman-Powell 2005). Hence, it becomes necessary to align to stakeholder-user considerations, as part of a participatory process of technology development. We therefore adopt the participatory action research paradigm to create an iterative technology development process that incorporates teachers' feedback as an important component.

Berman and Allara (2007: p. 115) define participatory action research (PAR) as "an approach to an alternative system of knowledge production, based on the community's role on setting the agendas, participating in data gathering and analysis, and in controlling the use of its outcomes". In allowing participating stakeholders to adopt a critical perspective in the research process, key principles of PAR include "participation, action and reflection, the empowerment and emancipation of individuals and groups ... and the production of various forms of knowledge" (Lennie and Tacchi 2007: p. 3).

A deeper understanding of the realities of teachers' ICT usage in classrooms, particularly in terms of the barriers that they face, allows for customized ICT initiatives that can be catered to address the unique challenges that teachers face. In doing so, the process not only aids teachers in utilizing ICTs in education but also puts them in better positions to actively participate in the creation of applications that they would subsequently use to teach.

We recognize that the PAR approach has rarely been adopted in ICT application design (Kajtazi et al. 2011; Lennie and Tacchi 2007) and when incorporated, has tended to focus on the technology, rather than the dynamics of participation (Kalra et al. 2007). Teacher involvement in application design could either be a one-off affair or they could be continually sought out for feedback in order to repeatedly improve an application. An iterative approach would empower teachers to engage in the development of educational materials prior to use. Prior research reveals that collecting first-hand information from users themselves, in this case teachers, resulted not only in a better final product but also increased their sense of ownership of the finished application (Chin 1996; Morris 2003). Additionally, the PAR process facilitates a collective reflection on macro-level cultural assumptions (McIntyre et al. 2007; Mohatt et al. 2004), as well as in eliciting individual-centric changes in teachers' attitudes and beliefs (Vaino et al. 2013). Following this line of reasoning, our research question investigates the influence of participatory action research approach in educational technology development on teacher attitudes of competence, confidence and capacity to change as conceptualizations of impact.

5 Context

In Peru, initiatives focusing on the integration of ICTs in classrooms began in the 1960s as a solution to geographical problems faced by the country (Trinidad 2005). Subsequently, significant resources have been devoted to the implementation of

ICTs in education such as INFOESCUELA (Info-school), Educación a Distancia (Distance Education), Plan Huascarán and Una Laptop por Niño (One Laptop per Child) (Marcone 2009). It is argued that, despite the investment, these projects allowed access to technological resources but had little impact on children's learning, not taking into account scholastic infrastructure, teacher training and more specifically, the needs and challenges of teachers and students (Derndorfer 2010; Martínez and Olivera 2012; Montero et al. 2009; Trinidad 2005).

The recent National Curriculum Design (Ministerio de Educación 2009) plan which encourages ICT use in schools resulted in a rapid uptake of computers in Peru's schools. As a result, teachers have been exposed to extensive computer training workshops that were initiated in response to their requests and encouraged to integrate technological tools into teaching practices. Therefore, Peruvian teachers have become generally technologically knowledgeable, though in varying degrees, in terms of operating basic computer programmes and using the Internet. Teachers, however, are very much at a nascent stage of trying to incorporate computers for academic subject-related purposes, using them primarily for general web surfing and information gathering.

According to PISA evaluations in 2001 and 2009, Peru occupies last place in reading comprehension and mathematical reasoning (Trathemberg 2010). Likewise, Montero et al. (2009) identify that Peruvian students reach very low levels of achievement in language and mathematics. Further, these authors also found that there were significant differences between state and private schools and that learning gaps were bigger between urban and rural areas. In a nationwide effort to advance pedagogy in local schools, the "*Programa Leer es Estar Adelante*" was initiated to improve reading comprehension among third to sixth graders in urban, suburban and peri-urban schools.

The Leer Programme has been active in select schools (993) for over 6 years across eight regions, involving over 2,000 teachers and 50,000 students, and has resulted in increases in the level of reading comprehension (BBVA Foundation 2011). Following an increased recognition of the positive impact that ICTs could potentially bring to educational outcomes, there was interest in utilizing digital resources to supplement the existing reading comprehension programme. The Instituto de Estudios Peruanos (IEP), the central institution responsible for the coordination and management of the programme, aimed to develop an e-learning element using the established Leer curriculum. The proposed innovation, Leer Digital, comprised software developed from a programme textbook for dissemination to computer classes and laboratories in chosen schools, for use by children guided by teachers. The aim was to investigate the impact of the digital textbooks on education, specifically on the reading comprehension of children. It was proposed that the software would allow students to interact in innovative ways with the current materials developed by the programme. We studied the educational software development as a participatory process, focusing on teachers as key stakeholders.

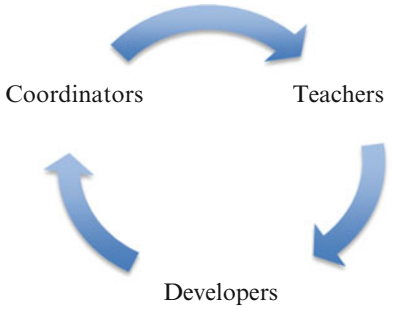

Fig. 1 Theorized PAR process in development of educational software

6 Methodology

Key aspects of participatory research that recommend it as a methodology for ICT projects include a focus on simultaneous data gathering and analysis, a flexible inquiry process that focuses on the lived experiences of participants as well as a cyclical approach to planning, acting, observing and reflecting on findings (Coghlan and Brannick 2001). As illustrated in Fig. 1, the theorized PAR process assumes a balanced conversation between the varied groups of teachers, coordinators and developers. This includes a variety of ethnographic approaches such as semi-structured and in-depth interviews and participant observations. Further, it has been noted that the PAR method should be adopted from the onset of application design and must involve constant monitoring (Tufte and Mefalopulos 2009). Towards this end, teachers' opinions and perceptions of the application were gathered at every stage of technology development prior to actual implementation.

7 Participants

Fieldwork was conducted in two primary schools in the urban and peri-urban districts of Lima—Nuestra Señora del Carmen in Cercado de Lima and Javier Pérez de Cuéllar in San Juan de Lurigancho—from May 2012 to December 2012, with three cycles of teacher interviews during the PAR process (at the beginning, during implementation of software and at the end of the school year). Schools were selected based on prior participation in the Leer Programme, existence of functional computer laboratories and a willing administration.

Seven fifth-grade teachers along with two computer laboratory staffs, comprising a total of four males and five females, participated in the study. Teachers, aged between 46 and 51, belonged to similar socioeconomic backgrounds. They had an average of 25 years of teaching experience in various Peruvian schools, of which they had spent about 14 years teaching in the respective two study schools and had used computing devices for an average of 4 years. The school children were familiar

with computer usage and expressed basic proficiency in a variety of computer skills, from typing on the keyboard to searching for information online. Ethical considerations included informed consent from teachers and the right to withdrawal at any stage of the project.

8 Procedure

Data were collected through teacher interviews and participant observations during weekly computer classes. An interview guide was designed based on the three components of attitudes defined in the framework: competence, confidence and capacity for change of teachers, with specific questions related to each component. Competence questions related to "integration of ICT in class", "abilities and competence" and "use of more applications for more purposes". Confidence questions were related to "kids know more than teachers" and "teachers are afraid to make mistakes in class". Capacity for change questions related to "teacher training received", "gaps in teacher training" and "capacity to handle classroom teaching using computers".

Interviews were audio recorded for transcription and translation purposes. The translations and transcriptions for analysis were conducted by a research assistant bilingual in English and Spanish. Thematic coding involving the interpretation and categorization of information was used for data analysis. Data were collected and reviewed concurrently, with transcripts reviewed and topics catalogued based on recurring issues. A triangulation of methods such as interviews and observations allowed for the cross-validation of the findings and to add to the emerging descriptions. Respondent comments and interpretations of observation notes are provided in the next section to highlight the analysis.

9 Findings and Discussion

The PAR process comprised of the collective commitment of various stakeholders—researchers, digital developers, Leer Programme coordinators and teachers, involved in the iterative technology development process. The process was studied as a baseline study then studied again during the first, second and third cycles of PAR. Analysis of the data reveals two broad themes worth reflecting upon. The first observation in viewing the impact of participatory methods in technology development suggests that there are both cumulative effects and diminishing returns to teacher empowerment and participation. The second observation is that PAR, beyond merely being a teacher-focused intervention, inherently involves negotiations among multiple stakeholders, each with varying powers of influence. These observations suggest a certain value for multi-stakeholder involvement, yet on the other hand, point to the limited impacts of the participatory model for any single group of users (teachers).

We conclude with comments on the internalizations of changes in values, attitudes and practices of individual participants and reflections on the role of researchers in the participatory process. It is worth noting that gender and age variables were not items of analysis; hence, we refer directly to teachers' comments.

Due to the dynamic nature of the educational context, it was necessary to equally recognize varying uses of technology in schools, where each translates to different thresholds of attitudes and skill levels. For that reason, we limited our analysis to teacher-level adoption and reaction to the development of an educational software within a formal education space that consists of interactions between teachers and children.

10 PAR Viewed as a Longitudinal Process: Cumulative Effects and Diminishing Returns

At the beginning of the research study, teachers were generally supportive of the strategy of technology introduction in education, yet exhibited a wide heterogeneity of attitudes and practices. Teachers' positive attitudes stemmed from a belief that the technology would benefit them as well as student learning, yet betrayed a sense of having bought into an ideology. Teacher 1 said that ICTs are "a tool that the government is trying to implement in order to improve quality of education". Teacher 2 echoed this sentiment, "we have to unite education and technology in order for children to learn more and be updated with advances".

While there was consensus on the potential benefits of technology introduction, in practical terms, however, teachers integrated ICTs into teaching in different ways, with some exhibiting proficiency and others at the opposite end of the spectrum, displaying a lack of confidence about their competence. Teacher 3 proposed visiting an online resource to review the water cycle, a topic previously reviewed in regular class, while Teacher 1 stated that students were required to search for information online using search engines and present their work using PowerPoint. Further, some teachers were willing to resolve ICT-related doubts raised by students. On the other hand, others faced difficulties in using technology in the classroom and depended largely on the assistance of computer laboratory assistants.

Most reluctant teachers admitted to a lack of confidence related to computing technologies, partially related to competence, as exemplified by Teacher 4, who claimed that "when I used a computer for the first time, I was lost and confused. I tried to handle the mouse but I could not". Despite gradually being able to manage to adopt the technology, Teacher 3 recognized that she continues to face technical trouble, claiming that "I still have problems with boxes in MS Excel. Sometimes I want to move or erase a line but I cannot, and in these aspects I need a little help". The lack of competence and confidence led to a limited capacity for change, with Teacher 5 sharing that during her first experience with ICT, she was "very afraid to spoil (the computer) or make a mistake". Beyond confidence and competence, the capacity for change was also seen to be related to age, with older teachers

pointing to a lack of experience. Teacher 3 said that "for me, it was very difficult and still is. Maybe it is due to (the) age that I am (in); we are not entirely involved into computers. We use these when it is necessary. . . . When I need, I use a computer but I am honest, I delay a lot. I spend many hours trying". For others, their relative computing knowledge versus that of their students was a reason to resist change. While the teachers articulated their role as a guide to students, the presence of computers acted as a source questioning their credibility. Teacher 8 said " . . . the intention is to use them (computers) but these are scary because sometimes it is complicated to keep order . . . ".

The PAR process involved observation, training and solicitation for improvement areas in the software from the respondents. Teachers expressed interest in receiving more ICT training, with Teacher 4 stating that "we work with students, but we have to be trained". All teachers attended a training workshop in each school to familiarize with the functional aspects of the first two software units (of five). During this training, some teachers had difficulties in using computers that ran the software. In both schools, teachers were nervous when they had to independently run the programme, while some faced difficulties in handling the mouse. Overall, however, it was found that teachers were interested in learning to use the digital software. Reflecting this sentiment, Teacher 3 said, "but without training we cannot develop this class in a right way".

Over time, the PAR process led teachers to take charge of their own learning and teaching approaches and consequently depended less on the laboratory assistants. To aid self-directed learning, teachers received USB flash drives containing a tutorial guide and the Leer Digital software. Teacher 3 indicated that this was crucial "because researchers gave USBs that helped us in addition to training . . . to know how the software is, and how we should use . . . it helped us". By this stage, a majority of the teachers expressed that they were confident in being able to use the software in classes. According to Teacher 5, "a group (of researchers) had come and taught us, a partner (of investigators) guided with tutorial and the rest, in addition I know something, I know how to use a computer . . . and practice. And by practicing we learn". Similarly, Teacher 2 mentioned that "having the portable version of the software in USB file, I can review it in my house using the tutorial card that they gave us to read. This way, we can familiarize with the software that we have (in school)".

It was found that teachers integrated software into their teaching practices in different ways, yet found noticeable impacts on students. Teacher 8 said "software Adelante is providing many advantages to our educational labour as teachers because it lets us motivate students, . . . children learn through play, . . . because they like to manipulate the computer a lot, . . . they learn easily (through computers) . . . they love coming to class". Although all teachers emphasized skills and strategies of Leer Digital sessions, they subsequently progressed with classes in different ways. While variances in teaching approaches are understandable, differences in teachers' competence to both incorporate the software to teaching and to control the class in a new ICT environment influenced the way in which learning with the software complemented Leer objectives.

With repeated practice and training, teachers maintained that they were knowledgeable about appropriate software usage. For instance, Teacher 5 said, "well, until now I had no problem . . . .I know how to use this educational software". Teacher 4 stated that he knew how to use the software, explaining that "because, more or less, we are following the instructions given to us since beginning". In other words, from the perspective of teachers, knowing how to use this software was related to the initial training received.

However, due to this perceived familiarity with the software, the feedback that was obtained from teachers declined. Teachers linked their improvements in competence and confidence with the training and supplementary materials received and subsequent iterations of the software. As the PAR process proceeded, it became increasingly difficult to get teachers to be critical about the software in terms of providing feedback to make significant changes to it.

After numerous iterative cycles of PAR, beyond technological competencies, teachers exhibited a nascent confidence in leading the technology intervention. Teacher 5 mentioned that "the role that teacher assume(s) is to be a guide . . . generates learning of students, but guides them". On the other hand, Teacher 1 mused that " . . . I have been a guide because I created conditions to bring something that was established, this is established because software is all planned, this has a sequence . . . ". Overall, it can be argued that being a part of the software development process gave teachers a sense of ownership over the technology and also to the general sense of responsibility over students' learning, hence prompting them to assume leadership positions in the learning process.

11 PAR as a Negotiated Process

The second observation is that PAR, beyond merely being a teacher-focused intervention, inherently involves negotiations among multiple stakeholders, each with varying powers of influence. This study was conducted on the premise that there is value to including teacher inputs in the technology development process. However, we realize that the motivations and influence of a variety of other stakeholders meant that teacher influence on the process was deeply contested and that the researchers played an important mediating role.

Teacher inputs garnered during the PAR process had varying degrees of success in being incorporated into the software and were largely dependent on the inputs of external stakeholders. The resultant negotiations led to situations in which teachers were able to influence the software development, those wherein teachers had to form alliances with other groups to make their opinion count, as well as instances where teachers' inputs were ignored completely.

During PAR feedback, Teachers 2 and 6 suggested that the software should include an exam at the end of each section to assess students. In response, researchers highlighted that the software was equipped with the option for generating student work as PDF files for assessment. However, Teacher 1 mentioned

difficulties in saving student work in the PDF format, which made it hard for her to review students' performance in each section. Other stakeholders, namely, coordinators of the Leer Programme, agreed that addressing problems with generating PDF versions was pertinent to improving the software. This glitch in the software was communicated to the digital developers who rectified it for subsequent units.

Another idea from teachers gained less traction, with different groups of stakeholders uniting in their opposition to it. Teacher 5's suggestion was to add an element of play, such as educational games, to effectively engage students. Coordinators of the Leer Programme rejected the proposal, feeling strongly that a play element "contradicted with the pedagogical approach of the original *Leer Adelante* book". Later in the process, the teacher repeated the idea, but the researchers, heeding the position of the coordinators, did not take this recommendation under consideration.

Similarly, Teacher 2 suggested that the software should include a sign or image that indicated to students if they got the right answer to questions. While researchers considered this a valid input, coordinators of the Leer Programme felt strongly that the software should not include this suggestion since correcting students was deemed to be the role of teachers rather than that of the software. In addition, Teacher 6 mentioned that at the end of each unit, the software should include a conceptual map that summed up progress made in class. This suggestion too was not incorporated in the software because researchers and Leer coordinators concluded that an existing feature of the programme "Me Autoevalúo" summarized students' progress to a similar extent. Researchers later clarified this option to teachers, who nonetheless considered it an insufficient response compared to the original request.

On the other hand, teachers sometimes formed alliances with other groups to push through their ideas. Teacher 4 felt that the software should include audio of readings of each unit, demonstrating to children reading techniques such as correct pronunciation. Researchers and coordinators of Leer Programme agreed that these changes were pertinent to improving the software. However, digital developers rejected these modifications as being too difficult to incorporate to the existing version of the software. After much persuasion, the developers agreed to make the changes in the version that was due in the following academic year.

It must be noted that participation occurred across the various stakeholders involved in the project, sometimes excluding the teachers. While teachers were engaged as participants, other groups were engaged in heated negotiations as well. Coordinators of the Leer Programme suggested that the software reflect the colour scheme adopted by the physical textbook, wherein various stages of the learning process for reading comprehension are uniquely colour coded. Developers were expected to incorporate the initial feedback to the development of unit 3. However, similar to the problems faced at the baseline phase when delays in deliverables were encountered, developers were not able to meet the expected deadlines for delivering subsequent units to schools, hence, once again, building tensions between researchers and digital developers.

The differences in work requirements and resultant schedules of the various groups of stakeholders were another source of tension for the participatory process. Delays in software delivery by the developers and national-level strike by teachers

not only delayed commencement of the PAR process with teachers but also interrupted the PAR schedule as agreed with schools. Hence, the majority of the feedback and interaction regarding the initial development of the software was limited to researchers and developers.

Further along in the PAR process, teachers did not review or reflect on modifications made, taking their role in the process for granted. It was observed that teachers tended to repeat their suggestions on improvements to software during the PAR. For example, Teacher 1 repeatedly brought up issues she faced with saving PDF files to assess student work, but this problem was solved in the first cycle. In addition, this teacher highlighted that the software include a feature to review student achievements over the weeks. However, when asked if she had checked the software upgrade recently, she mentioned not having the time to do so. Such instances demonstrated that teachers might not necessarily keep track of the improvements made to the software, where in some cases, they might merely repeat previously mentioned suggestions without much interest in recognizing the progress made to the software.

12 Challenges of Externalities to PAR

Externalities in the form of maintenance support and differential syllabi hampered the effectiveness of PAR as a tool to empower teachers in the adoption and usage of technology. Generally, teachers found it easy to use the software in classes but had issues with the lack of maintenance and inoperative computers in their schools. It was found that this dissatisfaction with the poor condition of computer hardware translated to teachers' lack of trust in being able to progress in classes with the software.

A secondary issue arose when teachers from different schools used the software during respective reading comprehension classes. While all teachers started with section 1 of unit 1, some of them chose to proceed without necessarily following the syllabus order as proposed by Leer. This could be because teachers advanced with the coursework at different levels. Another reason was that individual factors dictated the pace of teaching; school Teachers 5 and 6 did not conduct their classes because of "personal reasons". This lag between the PAR software iterations and proceedings in the class schedule adversely affected teacher participation in the programme, where they were both unprepared and unwilling to provide feedback on the Leer software.

13 Conclusion

This research study set out to interrogate the assumption that participatory processes in technology introduction in the domain of education would yield beneficial results. The PAR process may apply different definitions of impact to developmental

domains beyond that of education. Therefore in this study, impact was defined as empowerment of teachers in terms of their competences, confidence level and attitudes towards change. The approach assumed that an inclusive approach with a hitherto absent stakeholder, the teachers, as the focal point would lead to improvements in second-order benefits, as framed by Ertmer et al. (1999, 2012).

Defining impact in a development project related to education in terms of second-order benefits such as attitudinal and competence change of key stakeholder (teachers), rather than educational attainment of the ultimate beneficiary (students), creates problematic assessments. The objective of the project may begin with the premise that community dialogue and debate are the immediate objectives, leading into collective action (Figueroa et al. 2002), thus diverting attention and resources to the creation of participatory activities rather than keeping the end goals in sight. We caution against such conceptualizations of participation as an end in itself and a recognition that the community of stakeholders is diverse, both in its groupings and the motivations that guide it to action.

We note that over the course of time, teacher's attitudes improved with increases in technological capacities, a confidence to provide technological leadership in the classroom and a capacity to act as engaged participants in the technology development process. While these second-order benefits were being realized, we noticed increasingly diminished returns as the process went along. Teachers' identities regressed from technology development partners to their core identities as guides and leaders in the classroom. This behaviour may be considered a sign of success, as teachers were less reliant on the participatory process as source of support, but achieved a self-reliance in the use of the technology. This perspective on the iterative participatory process that recognizes a natural dynamic of ebbs and flow echoes Huesca's (2001) calls for attention to temporal dimensions of social movements.

It is important to note that the participatory process needs to acknowledge the varied motivations and skill sets of the engaged constituencies, rather than elevating a formerly ignored albeit important community into a focal position. The developers and coordinators were unwilling to accept the teachers' inputs as given, rather weaving these demands into their own objectives, leading to a back-and-forth negotiated process. These unforeseen realities of working with specific communities for PAR were not taken into consideration when planning the PAR process yet revealed a dynamic that could allow for multiple voices to create an output that is potentially better than one decided by a single group. Further research is required to judge whether educational outcomes at both student and teacher levels respond to such a collaborative technology development process.

Finally, we reflect upon the strange looking-glass dynamic of the PAR process because we, as researchers, cannot avoid being central characters. While the theorized process assumed an equal conversation between the varied groups, in reality (see Fig. 2), the researchers became the conduit for relaying and moderating the exchanges. It would be interesting to understand how such dynamics would be practiced in reality without the presence of a research group. Further, we acknowledge that the subsequent dissemination, usage and adoption of the

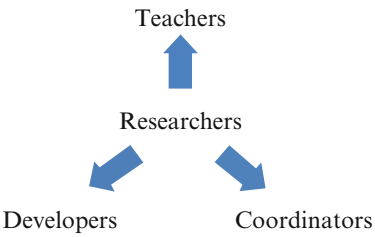

Fig. 2 Observed PAR process in development of educational software

digital Leer innovation by Peruvian teachers will occur without a technological development process. New questions shall necessarily arise—whether the principles of participatory democratic engagement in technology design and development translate into measurable impacts at the student level—and to be answered in the future.

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