Chapter 13

Impact of integrating OER in teacher education at the Open University of Sri Lanka

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Summary

This chapter reports on a research project implemented in the Faculty of Education at the Open University of Sri Lanka (OUSL) which investigated the impact of integrating Open Educational Resources (OER) in the teaching-learning process by secondary-level student teachers in Sri Lanka. The research questions this study seeks to answer are: What are the impacts of OER integration on the use of instructional materials by teachers? What are the impacts of OER integration on teachers' pedagogical perspectives? What are the impacts of OER integration on teachers' pedagogical practices?

The study adopted a design-based research approach. An intervention programme was implemented with 230 participants who were student teachers registered in the OUSL Postgraduate Diploma in Education programme in nine OUSL centres across the nine provinces of Sri Lanka. Data were collected at multiple stages through the following quantitative and qualitative strategies: survey questionnaires, analysis of lesson plans, concept mapping, self-reflection, semi-structured interviews, focus group discussions, usage data from the learning management system and narratives in the form of "stories". While descriptive statistical methods such as percentages were used to analyse the quantitative data, the authors employed an Interpretive Phenomenological Analysis approach to analyse the qualitative data.

Findings showed that the integration of OER had a substantial impact on changing teachers' instructional resource use, pedagogical perspectives and pedagogical practices. The careful and systematic design of activities facilitated a shift from a "low" to a "high" degree of innovative use of instructional resources as well as creation of OER by teachers, while their pedagogical perspectives and practices shifted towards more constructivist, context-centric and collaborative patterns, as well as to a participatory and sharing culture, in favour of Open Educational Practices. ▶

This kind of capacity-building of teachers in the adoption of OER has the potential to strengthen the school education system in Sri Lanka. Motivating teachers through provision of further opportunities, and recognition of their initiatives through incentives and appreciation, would enhance empowerment of teachers to act as "change agents". It will also provide insights to inform recommendations for the formulation of evidence-based guidelines to support OER adoption.

Acronyms and abbreviations

CERI	Centre for Educational Research and Innovation
COL	Commonwealth of Learning
CPD	continuing professional development
DBR	Design-Based Research
EFA	Education for All
ICT	information and communication technologies
MDGs	Millennium Development Goals
MoE	Ministry of Education
OEP	Open Educational Practices
OEP-IE	OEP Impact Evaluation
OERTL	OER-integrated Teaching and Learning
OER	Open Educational Resources
OUSL	Open University of Sri Lanka
PGDE	Postgraduate Diploma in Education
ROER4D	Research for Open Educational Resources for Development
UNISA	University of South Africa

Introduction

Article 26 of the Universal Declaration of Human Rights states that: "Everyone has the right to education."[1] This notion is reinforced by various "open" concepts that have evolved in relation to teaching and learning practices under the umbrella term "Open Education", which refers to a broad range of practices to enhance accessibility, flexibility and equity in education (Souto-Otero et al., 2016). The Open Educational Resources (OER) movement has enhanced such practices of openness through promoting the legal sharing of educational resources freely online (UNESCO, 2012; Wiley & Green, 2012). OER not only offers an efficient means of sharing knowledge, but also serves as a strategic opportunity to increase the quality of education through enhancing innovations in the use and creation of teaching-learning resources, thus contributing to sustainable development[2] (OECD, 2007).

1 http://www.un.org/en/universal-declaration-human-rights/
2 http://www.unesco.org/new/en/communication-and-information/access-to-knowledge/open-educational-resources/

Access to reliable and useful learning resources and the cost of these resources are often identified as substantial obstacles to education and training in developing-country contexts. The increasing availability of OER helps to address these challenges by making educational resources freely accessible, thus contributing to improved cost-efficiency (UNESCO, 2012). OER also play a key role in enhancing the participatory culture of learning, creating, sharing and cooperation required by rapidly changing "knowledge societies".[3] While access to knowledge and information is vital in the transition towards knowledge societies, effective use of information and knowledge to create new knowledge is a key factor in promoting socioeconomic equity. The transformation of information into knowledge and the creation of new knowledge require innovation. Thus, the values and practices of creativity and innovation play a major part in knowledge societies. The OER movement can have a substantial influence on educational practice, not only in making educational resources easily available and accessible, but also in contributing to the continuous quality enhancement of resources through the legal mechanism of granting rights to users to revise, remix and adapt them according to contextual needs. This empowerment of users to become creators, rather than merely consumers of content, necessitates creative and innovative pedagogical thinking and practice.

In the Sri Lankan education system, OER is still a relatively novel concept. Despite the fact that the Sri Lankan general education sector has made a contribution to economic and social development in the country through several policy reforms, issues such as limited use of up-to-date instructional materials and lack of engagement in innovative pedagogical approaches by teachers are often observed in the general schooling system (NEC, 2016). Several initiatives have been implemented to address the needs of the country's education system in order to meet the challenges of the new millennium. In particular, use of information and communication technologies (ICT) has been enhanced through various projects funded by the Asian Development Bank, such as the Secondary Education Modernization Project and the Distance Education Modernization Project, while the Education for Knowledge Society Project and the Education Sector Development Framework and Programme aimed to improve the quality, relevance, effectiveness and equity of access to secondary and tertiary education, specifically in rural and disadvantaged locations (MoE, 2012; 2013). A noteworthy progressive action took place in January 2017, when the government of Sri Lanka presented the Sri Lanka Sustainable Development Bill targeting the development and implementation of a national policy on sustainable development in line with the United Nations' Sustainable Development Goals, to be implemented in parallel with the government's Sustainable Era programme.[4] This endeavour should further enhance and promote Education for Sustainable Development initiatives in the Sri Lankan education system, including the adoption of OER in teaching and learning.

Several studies conducted at the Open University of Sri Lanka (OUSL) revealed that the level of OER awareness was extremely low among practitioners, yet their preparedness and motivation to adopt the concept was quite high (Karunanayaka, 2012; Karunanayaka, Fernando & De Silva, 2013). Subsequent initiatives implemented by the Faculty of Education at OUSL have resulted in increased levels of OER adoption among practitioners, instilling

3 http://www.capetowndeclaration.org/read-the-declaration
4 http://bit.ly/2zS943Y

a change in thinking and practice by raising awareness and developing capacity. Previous studies have highlighted the need to establish a close partnership between researchers and practitioners in awareness-raising and capacity-building initiatives, as well as the importance of designing appropriate experiences in a systematic manner (Karunanayaka & Naidu, 2013; Karunanayaka, Naidu, Dhanapala, Gonsalkorala & Ariyaratne, 2014; Karunanayaka, Naidu, Rajendra & Ratnayake, 2015).

It is expected that the development of a culture of adopting OER among academics in Sri Lanka will have a cascading effect on enhancing the quality of teacher professional development (Karunanayaka & Naidu, 2014). This process could be facilitated by encouraging student teachers in the OUSL Faculty of Education to integrate OER in their teaching, and studying the impacts of this process. Empowering school teachers with the competencies to use, create and adapt OER in their teaching-learning process and ascertaining its impact would hopefully ensure that the benefits of this innovation do not remain confined to OUSL, but filter down to the primary and secondary school systems.

The Postgraduate Diploma in Education (PGDE) programme offered by the OUSL Faculty of Education is an in-service professional development programme for school teachers offered in three languages (Sinhala, Tamil and English) and implemented in OUSL regional and study centres throughout Sri Lanka. This chapter reports on a study that engaged a representative sample of student teachers in the OUSL PGDE programme (i.e. teachers enrolled in the programme) and investigated the impact of integrating OER in their teaching-learning process.

"Impact" is described in terms of changes that happen over time due to an intervention (OECD, 2012). Since the concept of OER was novel for school teachers in Sri Lanka, an intervention was essential to support integration of OER in their teaching and learning. The aim of this study was to investigate how and in what ways integration of OER is having an impact on instructional resource use, pedagogical practices and pedagogical perspectives of Sri Lankan school teachers.

Conceptual framework

Theory of change

When integrating OER in teaching and learning, the responsibility for finding the most appropriate materials to use (and for utilising them) in order to support effective education resides with the institutions as well as the educators responsible for the delivery of education (COL, 2011). Conceptually, using OER is similar to using any other learning resource in teaching and learning. There is, however, a difference with OER in terms of the legal permissions provided by open licensing, which allows for additional flexibility in teachers' and learners' use of resources in terms of Wiley's "5Rs"[5] – the right to reuse, revise, remix, redistribute and retain the resource.

5 http://opencontent.org/blog/archives/3221

Adoption of OER by educators can only be truly effective if it is driven and accompanied by a "change" in their thinking and actions. Educational change is described as a complex process comprising four broad phases: initiation, implementation, continuation and outcome (Fullan, 2007). Emphasising the fact that "change is a journey, not a blueprint", Fullan (1993, p.21) points out that, in order to deal with such complexity, the focus should not be on controlling change but on guiding it. Educators are therefore expected to be "change agents". According to Fullan's view, every stakeholder in the educational change is a change agent: "It is only by individuals taking action to alter their own environments that there is any chance for deep change" (Fullan, 1993, p.51).

In light of the fact that change efforts often focus on materials and overlook people, it has been argued that if the intended outcomes of an educational innovation are to be achieved, it is essential to have changes in actual practice along three dimensions: the possible use of new or revised materials; the possible use of new teaching approaches; and the possible alteration of beliefs (Fullan, 2007). Considering integration of OER as an educational innovation, the conceptual framework of this study was formulated based on these three dimensions. Accordingly, the current study focuses on ascertaining the impacts of OER integration in teaching and learning specifically in terms of changes in the use of instructional materials by teachers, their pedagogical practices and pedagogical perspectives. The main research questions of this study are:

1. What are the impacts of OER integration on the use of instructional materials by teachers?
2. What are the impacts of OER integration on teachers' pedagogical perspectives?
3. What are the impacts of OER integration on teachers' pedagogical practices?

Literature review

The increased availability of a wide variety of quality teaching-learning materials online in the form of OER gives teachers and learners access to educational resources in diverse formats, which can enable flexible and dynamic knowledge creation. OER can, therefore, help developing countries save money as well as course-creation time (Kanwar, Kodhandaraman & Umar, 2010). In particular, use and adaptation of OER would be a very cost-effective way to invest in curriculum development and quality teaching-learning material development at regional and national levels within the Asian context (Dhanarajan & Porter, 2013). However, while rapid progress in practices related to use and creation of OER is evident in many developed countries, there has been slow progress in OER implementation in the developing world (Hatakka, 2009). It has been suggested that to reach its full potential, a global balance is needed, where developing countries are not confined to merely being consumers of OER, but instead also producers of OER (Albright, 2005).

The potential of OER to bridge the information gap between the developed and developing world is increasingly being realised (OECD, 2007). In recent years, substantial progress with steadily growing education-development efforts has been witnessed in the developing world, particularly in areas such as teacher training, open textbooks, locally developed OER and OER policy development (Hoosen, 2012; Smith, 2013). Notable initiatives include

OERAfrica,[6] OERAsia,[7] Teacher Education in Sub-Saharan Africa,[8] Teacher Professional Development in India[9] and the eGyanKosh[10] national digital repository in India. In the Sri Lankan context, actions are currently under way to develop and implement OER policies at the provincial ministries of education (Karunanayaka & Abeywardena, 2016).

Adoption of OER and Open Educational Practices in teaching and learning

The shift of emphasis from merely having access to resources to the practice of using OER is encompassed in the concept of Open Educational Practices (OEP). Promoting OEP through the creation, use and management of OER in teaching and learning is a very challenging process (Conole & Ehlers, 2010). It not only requires a change in terms of access to OER, but also a change in the mindsets of practitioners towards a more open, participatory, creative and sharing culture.

Various studies on the adoption of OER and OEP in teaching and learning reveal that OER are increasingly being widely and actively used in the education systems of many developed as well as developing countries (de los Arcos, Farrow, Perryman, Pitt & Weller, 2014; Dhanarajan & Porter, 2013; European Commission, 2012; 2013; Hylén, van Damme, Mulder & d'Antoni, 2012; JISC, 2011; McAndrew et al., 2009; Naidu & Mishra, 2014; OPAL, 2010). The successes, challenges as well as supportive and hindering factors in the adoption of OER and OEP which these initiatives have revealed, and which are discussed below, provide useful directions on how to effectively engage in OER integration and OEP.

Challenges in the adoption of OER by educators

Despite some penetration of OER in global education systems, many studies have revealed inadequacies in the awareness and understanding of OER among faculty. Awareness and knowledge of OER among the academic community in Asia have previously been found to be very low (Dhanarajan & Abeywardena, 2013). A study on the benefits and challenges in the use of OER conducted among Organization for Economic Co-operation and Development (OECD) member countries indicates that even though the majority are active in the area of OER, mostly through specific projects or institutional initiatives, in many countries there is a lack of knowledge about OER activities among educators (Hylén et al., 2012). Similarly, two consecutive Babson OER survey reports reveal that most (>70%) faculty in the United States (US) higher education system remain unaware of OER, and adoption of OER has yet to enter the mainstream of higher education (Allen & Seaman, 2014; 2016). Teachers' appreciation of the OER concept and willingness to use these resources can, however, be seen as a positive trend. Further, a decrease in faculty concerns about permission to use or change OER and an increase in concerns about the quality of OER imply an increasing understanding of OER use (Allen & Seaman, 2014; 2016).

6 http://www.oerafrica.org/
7 https://oerasia.org/
8 http://www.tessafrica.net/
9 http://www.tess-india.edu.in/
10 http://egyankosh.ac.in/

According to the *OER Evidence Report 2013–2014* (de los Arcos et al., 2014), while awareness of OER and Creative Commons (CC) licensing[11] is growing, knowledge of OER repositories remains relatively low. This is a key obstacle in locating OER. Studies exploring staff attitudes toward OER found that despite limited knowledge and awareness of OER, they had positive attitudes about sharing materials[12] (Karunanayaka, 2012). This kind of sharing culture among faculty and the willingness to embrace the OER concept are promising signs that should enhance the adoption of OER.

The benefits of using, producing and sharing OER – such as open and flexible learning opportunities, increased efficiency and quality of learning resources, cost-efficiency and innovation potential – result in a systemic transformation affecting all parts of education systems (Hylén et al., 2012). Educators mainly use OER to broaden their teaching methods and the range of resources available to their students. Relevance, high quality and discoverability are therefore key requirements for educators to adopt OER (de los Arcos et al., 2015).

Despite growing evidence of the benefits of OER, there are many issues influencing OER adoption by educators. Lack of awareness of open licensing, inability to judge the quality of OER, as well as the extensive time and effort required to find relevant OER and evaluate them, are some of the common barriers to the adoption of OER identified in previous studies (Allen & Seaman, 2014; CERI/OECD, 2007; de los Arcos et al., 2014; Dhanarajan & Porter, 2013). These studies also reveal that only a small minority of educators create resources and publish them under a CC licence.

For instance, Babson surveys conducted in 2014 and 2016 found that OER was not a driving force in resource-adoption decisions by faculty in higher education systems in the US, and levels of OER use by faculty were therefore found to be low. The most significant obstacle revealed for OER adoption by faculty was the effort required to find and evaluate such materials (Allen & Seaman, 2014; 2016). Similarly, key barriers to OER use in OECD countries included lack of time and lack of a reward system (CERI/OECD, 2007).

A survey conducted on OER uptake among staff at the University of South Africa (UNISA) indicated that, despite high levels of awareness and knowledge about OER, there has not been a change in practice, mostly due to a lack of knowledge about open licensing (de Hart, Chetty & Archer, 2015). Furthermore, results of a representative survey of higher education institutions in five European countries (France, Germany, Poland, Spain and the United Kingdom [UK]) on OEP, beliefs and strategies revealed that while OER are widely used and more than 50% of higher education institutions support the use of OER, just over one-third support the development of OER (Castaño-Muñoz, Punie, Inamorato, Mitic & Morais, 2016).

Cultural obstacles to sharing or using resources developed by other teachers or institutions have been observed in several OECD case studies (CERI/OECD, 2007). There is also evidence of learners being confused by the vast range of ideas and concepts they are exposed to through a wide variety of OER (Beetham, Falconer, McGill & Littlejohn, 2012). This illustrates the need to provide careful orientation and guidance to both teachers and learners in the use of OER. However, evidence of the "viral" effects of openness has been observed, based on reports that most OER users would continue to use them and would

11 http://creativecommons.org/licenses/

12 http://www.researchinlearningtechnology.net/index.php/rlt/article/view/14395

recommend them to others. Many educators encourage their colleagues to use OER and are keen to make their practices more open (de los Arcos et al., 2014). These observations suggest that exposure to OER tends to lead to increased use and sharing of these resources with others.

Practices in the integration of OER in teaching and learning

Even though acceptance of OER and its integration in teaching and learning is increasingly observed in mainstream education, evidence of its impact is still "mixed" (Weller, 2014). The practices adopted by educators in integrating OER in their teaching-learning processes play a major role in the levels of impact these resources have.

Enhancing pedagogy and students' learning experiences are some of the main motivations for implementing OER integration programmes. However, it has been observed that a majority of teachers use OER to supplement traditional face-to-face instruction, rather than as core learning materials (Souto-Otero et al., 2016). Many teachers claim that using OER requires more preparation time than when using traditional materials (Bliss, Robinson, Hilton & Wiley, 2013). This could be due to the time required to adapt OER to their needs, which may be a hindering factor in the actual integration of these resources in the learning process. A study on K–12 school teachers' perceptions of the role of OER emphasised that teachers do not merely adopt OER, but adapt them to suit diverse learning needs. Mainstreaming OER is not only a matter of raising awareness, but of changing teachers' habits (de los Arcos, Farrow, Pitt, Weller & McAndrew, 2016).

Studies on OER adoption in academic practice have identified numerous challenges faced by educators, and imply the need for continuing professional development (CPD) to enhance their practices (Browne, Holding, Howelle & Rodway-Dyer, 2010; Masterman & Wild, 2011). A study on the role of OER in transforming pedagogy reveals how exposure to OER supports collaborative practices among educators (Petrides, Jimes, Middleton-Detzner & Howell, 2010). The finding that OER use encourages reflection by educators on their own practice is another important aspect that should be promoted to enhance pedagogical practice (Weller, de los Arcos, Farrow, Pitt & McAndrew, 2015). These findings have important implications for how OER could be integrated in teaching and learning, particularly in relation to the design of CPD programmes for teachers.

A study incorporating six case-study research projects around the world (in Uganda, the US, South Africa and India) conducted by the Institute for the Study of Knowledge Management in Education highlights the role of OER in supporting teacher professional development and teacher knowledge-sharing (ISKME, 2008). The case study on Curriki,[13] a wiki-based website that facilitates teachers' reuse, remixing, creation and sharing of OER, identified the need for training support in order for users to create and remix content, and emphasised the importance of promoting interaction among users. Moreover, the case study on Training Commons[14] revealed that cultural context plays an integral role in OER partnerships. The Teachers' Domain[15] case study illustrated that the transition from

13 http://www.iskme.org/content/curriki-facilitating-use-and-user-engagement-around-open-educational-resources

14 http://www.iskme.org/content/oer-case-study-training-commons-institute-study-knowledge-management-education

15 http://www.iskme.org/content/oer-case-study-training-commons-institute-study-knowledge-management-education

proprietary materials to OER presented complex challenges to teachers, necessitating thorough assessment of legal, pedagogical and technical aspects prior to integrating OER. The participatory approach adopted in these case studies, with the aim of continuous improvement of practices, reveals the importance of capacity-building with ongoing assessment of practices, as well as the need to document and share these practices with a wider community (ISKME, 2008). Several case studies conducted in the Asian context likewise reveal similar findings (Dhanarajan & Porter, 2013; Karunanayaka & Naidu, 2013; Naidu & Mishra, 2014). These case studies provide invaluable insights into good practices in the adoption of OER and OEP in teaching and learning.

Moving from OER to OEP

OER may increase flexibility and equal opportunity in the use of learning resources, resulting in improved accessibility and enhanced openness in education. Broadening the focus of attention beyond mere access to resources to include innovative use of resources results in OEP (Ehlers, 2011). According to Wiley's "5Rs" OER framework, users are not only permitted to make free use of materials, but also have the ability to repurpose them through improvement of existing materials and creation of new materials, as well as adopt innovative teaching practices using OER. This empowers users to engage in innovative OEP employing different degrees of openness in the usage and creation of OER.

Whereas OER focuses on resource access, OEP focuses on how openness can be practised through the use, creation and management of OER via innovative instructional methods and strategies. While a simple definition of OEP such as "a set of activities and support around the creation, use and repurposing of OER"[16] implies this idea, a broader definition provides a more holistic view of OEP as "practices which support the (re)use and production of OER through institutional policies, promote innovative pedagogical models and respect and empower learners as co-producers on their lifelong learning path" (Ehlers, 2011, p.3). Beetham et al. (2012), in a study based on outcomes of a UK OER programme, state that OEP encompass several aspects: production, management, use and reuse of OER; developing and applying open pedagogies in teaching practice; gaining access to open learning opportunities; practising open scholarship; open sharing of teaching ideas; and using open technologies.

Attempts at integrating OER and OEP in teaching-learning situations have revealed supportive as well as hindering factors. These provide insights into how to effectively engage in such processes (Carey, Davis, Ferreras & Porter, 2015; Coughlan & Perryman, 2015; Karunanayaka & Naidu, 2013; 2016a; Karunanayaka et al., 2014; Karunanayaka, Naidu, Rajendra et al., 2015; Lane & van Dorp, 2011). While efficient integration of OER is supported by ICT, effective use of OER in teaching and learning can only be enhanced through adopting systematic course design processes.

16 http://e4innovation.com/?p=373

Various OER integration initiatives have presented frameworks for implementing OEP in different contexts, providing strategies and frameworks for consideration when designing, developing, implementing and evaluating OER. Examples include:

- The Open Educational Quality Initiative project's OEP matrix (Andrade et al., 2011), in which the link between resources and practices is captured and explained in two dimensions – openness in resource usage and creation versus openness in pedagogical models.
- The "7C" learning design framework (Conole, 2014), which presents seven elements of OEP implementation – conceptualise, capture, communicate, collaborate, consider, combine and consolidate.
- A model of "open pedagogy" (Hegarty, 2015), which discusses eight interconnected attributes – participatory technologies; people, openness and trust; innovation and creativity; sharing ideas and resources; connected community; learner generated; reflective practice; and peer review.
- A "learning engine" framework (Naidu & Karunanayaka, 2014), which functions as an effective strategy to design effective, efficient, engaging learning experiences based on innovative pedagogical models with OER as fuel for the learning engine.

These frameworks demonstrate how adoption of OER and OEP can be facilitated by creating structured enabling environments.

It is evident that enacting change towards OEP is best achieved through the strategic, systematic design of appropriate learning experiences. Designing effective, efficient and engaging learning experiences that adopt more context-centric learning approaches based on innovative pedagogical models supported by OER is identified as a viable solution to enhance a change in perspectives and practices among teachers in order to move towards OEP (Karunanayaka, Naidu & Menon, 2016; Naidu & Karunanayaka, 2014; 2015).

Methodology

The aim of this study was to investigate how and in what ways integration of OER in teaching and learning is having an impact on Sri Lankan school teachers, particularly with regard to changes in their instructional resource use, pedagogical practices and pedagogical perspectives. Ascertaining the impact of the OER integration process requires a realist understanding of causality (Maxwell, 2004), using a qualitative research approach. Hence, a Design-Based Research (DBR) approach (Reeves, 2006), which is a realist, process-oriented research approach, was adopted in this study.

DBR is a systematic and flexible methodology aimed at improving educational practices through iterative analysis, design, development and implementation. It is based on collaboration amongst researchers and practitioners in real-world settings, where researchers play the dual roles of both researchers and designers in the research process, leading to contextually sensitive design principles and theories (Wang & Hannafin, 2005). Since OER is a new concept for school teachers in Sri Lanka, it was necessary to first raise their awareness of OER and the opportunities afforded by these resources, and to build

their capacity in identifying, searching, selecting and integrating OER in their teaching and learning. Next, successive action was taken to design, develop and implement solutions to authentic problems in teaching and learning through teachers' active participation in the process.

The DBR approach comprises four phases: analysis of practical problems experienced by researchers and practitioners in collaboration; designing, developing and implementing solutions as appropriate; testing and refining solutions in practice; and reflection by researchers and practitioners on authentic problems to produce design principles and enhance solution implementation (Reeves, 2006) (Figure 1).

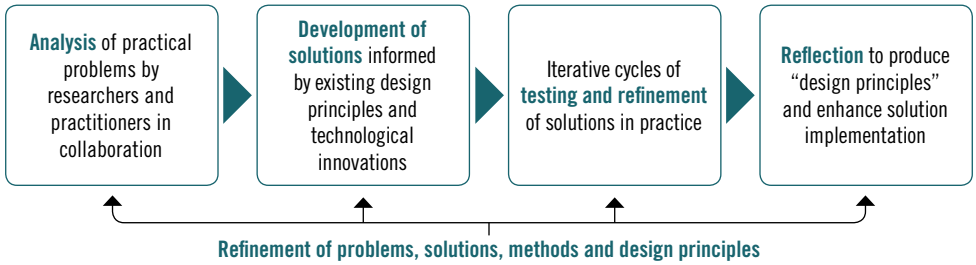

Figure 1: The four phases of Design-Based Research (source: Reeves, 2006)

Within a DBR framework, complex problems in educational practices are addressed in real-world contexts in collaboration with practitioners. Known and hypothetical design principles are then integrated with technological advances in order to render plausible solutions to these problems. Thereafter, rigorous, reflective enquiry is undertaken to test and refine innovative learning environments as well as define new design principles (Reeves, 2006). As such, DBR extends beyond the mere design and testing of interventions, and it has been claimed that DBR researchers, rather than simply "observing" interactions, are actually "causing" those same interactions (Barab & Squire, 2004). DBR is characterised as pragmatic, grounded, iterative and flexible, as well as interactive and contextual (Wang & Hannafin, 2005).

Situating the process in naturalistic contexts is identified as a core feature of DBR (Barab & Squire, 2004). DBR therefore serves as a useful approach where researchers function as designers to design solutions/strategies in collaboration with practitioners in order to improve their educational practices in real-life situations. In this study, where the goal was to ascertain the impact of OER integration in terms of changes in teachers' use of instructional resources, pedagogical thinking and pedagogical practices, DBR was considered the most desirable and appropriate research approach. Accordingly, a multiphased intervention was designed in order to support, test and refine teachers' OER integration practices in their teaching-learning process.

The intervention process

The intervention was designed and implemented in several stages utilising specific strategies in accordance with the four phases of the DBR approach.

Table 1: Strategies adopted during the intervention process in accordance with the DBR approach

Phases in the DBR approach	Intervention process		
	Intervention strategies	Purpose	Specific activities
1. Analysis of practical problems by researchers and practitioners in collaboration	• Pre-intervention survey • Orientation workshop	• Reflect on current thinking and practices in relation to use of instructional methods and materials by teachers	• Administering the pre-intervention questionnaire • Individual concept-mapping exercise • Analysis of teachers' lesson plans • Focus group discussions
2. Development of solutions informed by existing design principles and technological innovations	• Strategic and systematic design of learning experiences based on situated learning principles • Designing a series of interactive workshops for capacity-building, supporting and monitoring, reviewing and evaluation • Designing a learning management system (LMS) to support OER integration	• Capacity-building • Supporting teachers to integrate OER • Use of technology (LMS) to support teachers' integration of OER • Monitoring teachers' adoption of OER	• Designing a sequence of experiences to enhance the integration of OER and adoption of OEP among teachers • Workshop activities • LMS activities • Monitoring activities

3. Iterative cycles of testing and refinement of solutions in practice	• Capacity-building workshops • LMS to support OER adoption • Monitoring workshops • Reviewing/ evaluation	• Capacity-building and providing guidance to integrate OER • Encourage lesson planning with OER integrations and upload in LMS • Enhance sharing of OER via LMS • Monitoring, reviewing and supporting • Stimulating collaboration, cooperation, extension activities and sharing of good practices • Promoting reflective practice • Data collection	• Hands-on individual and group activities to identify/search/select OER, and planning lessons with OER integration • Providing links to OER repositories via LMS • Encouraging teachers to share OER found, reused, revised, remixed or created via LMS • Providing constructive feedback through constant communication via LMS • A competition initiated to find the most active teacher in each centre and the most active centre • Encourage extension activities at school/ centre/zonal levels • Concept-mapping exercise • Reflective journal writing • Questionnaire survey • Focus group discussions
4. Reflection to produce design principles and enhance solution implementation	• Teacher reflections • Researcher reflections	• Using teacher and researcher reflections to find solutions to authentic problems	• Compilation of "stories" by teachers and researchers based on their reflections • Creation of a weblog to share the stories of teachers' and researchers' experiences • Development of a tool to ascertain the impact of OER and OEP adoption by educators (OEP-IE Index) • Development of an enhanced framework on the use of DBR to support the adoption of OER and OEP

As summarised in Table 1, the four phases in the DBR approach were implemented in iterative cycles during the intervention process, using a number of different strategies, including specific activities that also served as systematic data-gathering techniques, both qualitative and quantitative. Details of each phase are described next.

Phase 1: Analysis of practical problems by researchers and practitioners in collaboration

In the pre-intervention phase, the existing situation with teachers in relation to the three aspects – instructional resource use, pedagogical perspectives and pedagogical practices – was analysed. The purpose was to reflect on the current thinking and practices of teachers, in order to identify the required solutions to improve the existing situation. A pre-intervention questionnaire survey, concept-mapping exercise, observation of lesson plans and focus group discussions revealed existing levels of thinking and practices related to OER, and indicated the need to raise awareness and build capacity among teachers in relation to integration of OER in their teaching.

Phase 2: Development of solutions informed by existing design principles and technological innovations

Phase 2 of the intervention involved designing effective, efficient, engaging learning experiences, as informed by existing theoretical constructs and frameworks based on situated learning principles and a constructivist approach to learning (Brown, Collins & Duguid, 1989; Duffy & Jonassen, 1991), as a solution to improve the existing condition of limited thinking and practices among teachers on integrating OER.

This phase consisted of developing two key components: designing a series of interactive workshops (two at each of the nine OUSL centres) and creating an online environment titled "OER-integrated Teaching and Learning" (OERTL) using a Moodle LMS. These two components included specific activities on capacity-building, guiding, monitoring and providing support on, as well as reviewing and evaluating, OER adoption by teachers.

The initial interaction workshops were designed to raise awareness and develop skills through intensive hands-on activities focused on identifying, searching, selecting and integrating OER in teaching practices (both individually and collaboratively), and included the following components:

- Introduction to OER and related concepts through presentations and discussions.
- Identifying OER, including understanding CC licensing.
- Searching different types of OER (subject-related resources).
- Identifying different ways of integrating OER (in terms of subject focus).
- Sharing sample learning designs (lesson plans) with integrated OER.
- Reflecting on the experience.

The OERTL online environment was organised into several sections serving different purposes, including an introduction to OER, separate sections for key subject areas with links to OER repositories, and discussion forum sections for sharing OER. Figures 2 and 3 present screenshots from the OERTL showing the introductory section with web resources to introduce the concept of OER (Figure 2), and forums to add useful OER found by participants and to share any OER created by participants (Figure 3).

Figure 2: The OERTL homepage

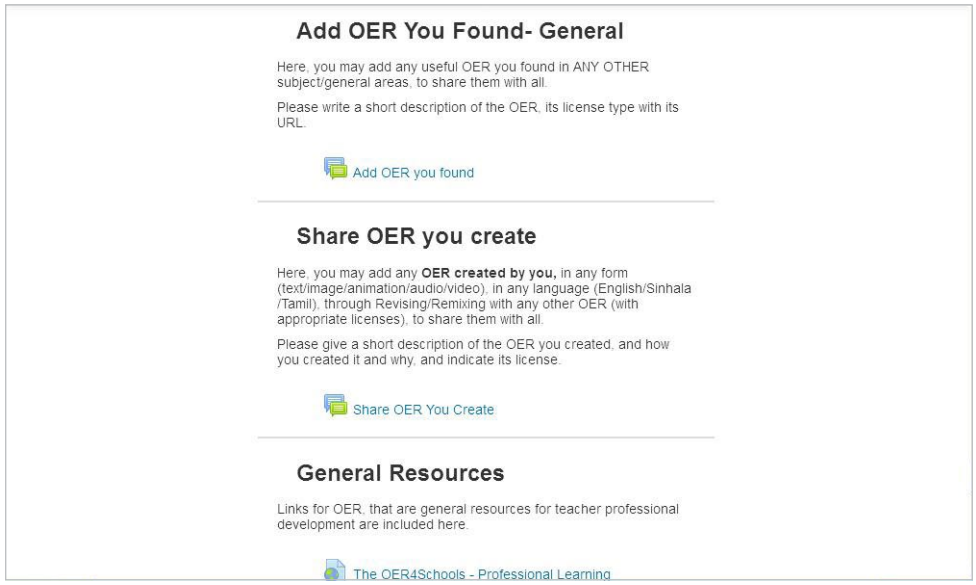

Figure 3: Web page for adding and sharing OER in the OERTL

As shown in the screenshots in Figures 2 and 3, OERTL was organised in a way that motivated and supported teachers not only to search, identify and integrate OER, but also to share OER with peers, upload OER-integrated lessons and concept maps and reflect on their experiences.

Phase 3: Iterative cycles of testing and refinement of solutions in practice

In Phase 3, during a series of workshops conducted at the nine OUSL centres, iterative cycles of testing and refinement of strategies in the designed learning experience occurred, together with constant interactions facilitated by the OERTL platform.

Specific activities conducted during this phase, which also supported continuous data collection, were:

- Providing hands-on individual and group activities during the workshops to identify/search/select OER and to support lesson planning with integrated OER.
- Providing subject-related links to OER repositories via the OERTL.
- Encouraging teachers to use the OERTL to share the OER found/reused/revised/remixed/created by them.
- Providing constructive feedback during workshops and through the OERTL.
- Maintaining constant communication via the OERTL.
- Initiating a competition to find the most active teacher in each centre and the most active centre.
- Encouraging extension activities to be initiated at school/centre/zonal levels.
- Conducting the concept-mapping exercise.
- Encouraging reflective journal writing.
- Administering surveys on teachers' thinking and practices related to OER integration.
- Conducting focus group discussions on teachers' thinking and practices related to OER integration.

Phase 4: Reflection to produce design principles and enhance solution implementation

During the DBR process, researchers and practitioners engage in reflective enquiry, systematically refining the learning environment, which results in the definition of new design principles that can guide similar research and development endeavours (DBR Collective, 2003; Reeves, 2006). This occurred during the final phase in the study.

Throughout the intervention process, both teachers and researchers were encouraged to record self-reflections on their experiences and insights gained at different stages. This activity aided the discussion on finding solutions to authentic problems. Later, based on these reflections, narratives were compiled in the form of "stories". These stories were shared with all as published OER, initially as a weblog[17] and later as an edited monograph (Karunanayaka & Naidu, 2016).

The process also resulted in the development of a tool to ascertain the impact of the adoption of OER and OEP – the OEP Impact Evaluation (OEP-IE) Index (Naidu & Karunanayaka, 2017).

Development of the OEP Impact Evaluation Index

During the intervention process, the idea of a specific instrument to ascertain the impact of OER integration and OEP adoption in teaching and learning emerged. The intention was that when administered at regular intervals over a period of time, the tool could capture

17 https://oertlousl.wordpress.com/

behavioural shifts in the perceptions, perspectives and practices of teachers in relation to OEP. This instrument was called the Open Educational Practices Impact Evaluation Index.

The development process of the OEP-IE consisted of three phases: expert review, item analysis and pilot testing with participants.

Initially, a pool of draft items (statements) was developed based on a review of the literature by the researchers and rated under three main categories: pedagogical beliefs (PB), pedagogical practices (PP) and instructional resource use (IR), with 45 items distributed among the three categories (PB = 15, PP = 15, IR = 15). These were systematically sorted and revised during the three development phases, resulting in 42 items in three categories (PB = 15, PP = 15, IR =12) (see Naidu & Karunanayaka, 2017).

This instrument was not used to collect data from the participants during the process, but it was pilot-tested with them. Statistical analysis of reliability and validity of the instrument is yet to be undertaken.

The overall process of reflection throughout the intervention process resulted in the development of new design principles in the form of a framework on the use of DBR to support the adoption of OER and OEP (see Karunanayaka & Naidu, 2017).

Participant profile

The study participants (n = 230) were recruited by mailing an open invitation letter to student teachers registered in the OUSL PGDE programme at nine OUSL centres – Anuradhapura, Badulla, Batticaloa, Colombo, Jaffna, Kandy, Kurunegala, Matara and Ratnapura. A filtering process was undertaken on the full, final list of respondents in order to select teachers of secondary-level grades.

The following factors were also taken into consideration in the participant selection process:

- Representation from the nine provinces of the country.
- Representation from different ethnicities and language or medium of instruction (Sinhala, Tamil and English).
- Representation in gender profile, addressing any possible gender inequalities in data analysis.

The participant cohort of 230 student teachers included 152 females (66%) and 78 males (34%). The centres of Jaffna (16.5%), Batticaloa (15.7%) and Colombo (14%) had the highest number of participants. More than half (57.8%) of the participants were science graduates, with some (17.4%) holding postgraduate qualifications. A majority (75.7%) had less than five years of teaching experience, while 22.6% had 6–15 years of experience, and only 1.7% had more than 15 years of experience. The subject most of the participants were teaching was science (44.4%), with the other main subject areas being mathematics (25.6%), languages (18.6%), commerce (14.3%) and information technology (14.3%). Participants' initial proficiency in using the LMS was found to be very low: the majority (74.3%) claimed poor competency, 22.1% claimed average competence and only 3.4% claimed excellent competence (Table 2).

Table 2: Background information on participant cohort (n = 230)

Aspect	Category	Number	Percentage
Gender	Female	152	66.1
	Male	78	33.9
Academic qualification	BSc degree BA/BCom degree Other degree	133 77 20	57.8 33.5 8.7
	Postgraduate	40	17.4
Professional teaching experience	<5 years	174	75.7
	6–15 years	52	22.6
	>15 years	4	1.7
Subject area (teaching)	Science	102	44.4
	Mathematics	58	25.6
	Languages	43	18.6
	Information technology	33	14.3
	Commerce	33	14.3
	Religion	10	4.4
Proficiency in using LMS	Poor	171	74.3
	Average	51	22.1
	Excellent	8	3.4

Data collection approach

All data collection strategies and instruments were designed and prepared based on a review of relevant literature on OER and OEP after several rounds of discussion among the research team. Validation of the instruments took place through expert reviews and pilot testing, where appropriate.

A comprehensive approach to data gathering was adopted throughout the research process, with data being collected at various stages of the intervention via multiple methods. These methods were comprised of the following quantitative and qualitative strategies: survey questionnaires, analysis of lesson plans using a checklist, concept mapping, self-reflection, semi-structured interviews, focus group discussions, analysis of activity logs in the LMS and narratives in the form of "stories". Table 3 presents a summarised overview of the data collection strategies associated with each of the research questions.

Table 3: Data collection strategies according to research questions

Research question	Data collection strategies	Purpose
1. What are the impacts of OER integration on the use of instructional materials by teachers?	1. Survey questionnaire 2. Analysis of lesson plans using a checklist 3. Focus group discussions 4. Interviews 5. LMS records 6. Self-reflection 7. Narratives ("stories")	To capture how/in what ways and for what purposes OER are integrated in the teaching-learning materials used by teachers (pre, mid and post intervention)
2. What are the impacts of OER integration on teachers' pedagogical perspectives?	1. Survey questionnaire 2. Concept mapping 3. Focus group discussions 4. Interviews 5. Self-reflection 6. Narratives ("stories")	To capture how engagement with OER has affected pedagogical thinking/ understanding/beliefs of teachers (pre, mid and post intervention)
3. What are the impacts of OER integration on teachers' pedagogical practices?	1. Survey questionnaire 2. Analysis of lesson plans using a checklist 3. Focus group discussions 4. Interviews 5. LMS records 6. Self-reflection 7. Narratives ("stories")	To capture how/in what ways and for what purposes OER are integrated in teachers' pedagogical practices (pre, mid and post intervention)

Survey questionnaires

Questionnaires were developed to obtain information from the participants at pre-, mid- and post-intervention stages. The questionnaires consisted of closed- and open-ended questions exploring the following main topics:

- Participant background information.
- Awareness of OER and views about sharing teaching-learning resources.
- Selection and use of teaching-learning resources.
- Perceptions of openness in education, OER and related concepts and practices.

Initially, draft questionnaires were developed and pilot-tested with a small group of teachers with the same characteristics as the research participants. These were also subjected to expert review. Based on the feedback received, the items in the questionnaires were revised and refined.

The pre-intervention questionnaire was administered manually, while mid- and post-intervention questionnaires were administered electronically via the LMS.

Checklist

A checklist was prepared to review the lesson plans of participants in terms of the following categories:

- Pedagogical approach.
- Teaching-learning methods and techniques employed.
- Integration of teaching-learning resources.
- Overall comment.

Concept mapping

Participants were required to develop single-page concept maps during pre-, mid- and post-intervention stages, illustrating all concepts and practices related to OER according to their current thinking. Specific guidelines were provided addressing the following key aspects:

- Identification of key concepts and related sub-concepts (organised hierarchically).
- Connecting concepts using lines/arrows to demonstrate meaningful links.
- Providing labels to indicate relationships between connected concepts.
- Providing specific examples of concepts.

Self-reflective narratives

Participants were asked to maintain self-reflective journals throughout the intervention process following specific guidelines. They were required to write reflective notes whenever they completed a key activity, addressing the following core focus areas:

- Analysis of the importance of the activity.
- Impact of the experience on the participant and others.
- Issues arising and how these were overcome.
- Successes and failures.
- Impact of the experience on individuals.
- Whether things could have been done differently, and, if so, how?

Focus group discussions

A schedule consisting of nine questions was used to gather data through focus group discussions conducted with small groups of participants (five or six in each group, formed according to the subject taught) in each OUSL centre during pre-, mid- and post-intervention stages. The nine focus questions addressed the following key areas:

- Considerations in the selection of teaching-learning methods and instructional resources.
- Methods of integrating OER in teaching and learning.
- Challenges in OER adoption and how to overcome them.

Semi-structured interviews

Semi-structured interviews were held with selected participants (two or three from each centre) using an interview schedule consisting of questions addressing the following key areas:

- Starting points.
- Integration of OER in lessons.
- Challenges and frustrations.
- Achievements and successes.
- Good practices.
- Impact on teaching and learning.
- Future plans.

LMS records

Data on participants' LMS activity were continuously recorded and observed in order to further refine intervention activities.

Utilisation of the multiple data-gathering strategies described above helped to ensure validity through methodological triangulation (Bekhet & Zauszniewski, 2012; Morse, 1991), and helped to provide a comprehensive view of the effects of this intervention.

Data analysis methods

While descriptive statistical methods such as percentages were used to analyse quantitative data, detailed content analysis of qualitative data was the main data analysis method used to capture meaning through close engagement with content in a process of coding and interpretation. This allowed the researchers to make sense of participants' ideas, understanding, thoughts and feelings and to analyse how those changed during the course of study.

Using Interpretive Phenomenological Analysis – an approach in phenomenological psychology that is commonly used to provide insight into how a given person in a given context makes sense of a given phenomenon – helped the researchers to explore in detail participants' perceptions of the particular situations they were facing, and how they were making sense of their personal and social worlds (Smith & Osborn, 2003). This approach allowed the researchers to uncover the meaning of individual experiences based on participants' and researchers' interpretations of their "lived experiences" (Reid, Flowers & Larkin, 2005).

In addition to content analysis, concept maps were also analysed based on their morphological types (Kinchin, 2008). A concept map provides a graphical representation of an individual's structural knowledge or conceptual understanding of a particular topic, and can be used to visualise and measure the depth, breadth and organisation of their understanding (Novak & Cañas, 2008).

Narratives were analysed using a framework articulated by Rolfe, Freshwater and Jasper (2001), which presents three questions to the practitioner: "What?", "So what?" and "Now what?" "What?" describes the situation in terms of achievements, consequences, responses, feelings and problems; "So what?" describes what has been learned in terms of knowledge gained about self, relationships, models, attitudes, cultures, actions, thoughts, understanding and improvements; and "Now what?" identifies what needs to be done in order to improve future outcomes and develop learning. The emergent themes and patterns of meaning identified were used to ascertain the changes that occurred in the pedagogical beliefs and practices of participants. Narratives or stories of both practitioners and researchers were also used to explore understanding gained of particular phenomena in real-world settings.

The qualitative, "realist, process-oriented approach" (Maxwell, 2004) employed in this study relied on an understanding of the processes through which a situation occurs rather than on a comparison of situations involving the presence or absence of the presumed cause. In investigating the causal mechanisms surfaced in the multiple data-gathering approaches used throughout the intervention, causation was demonstrated through evidence of "physical causality" (Mohr, 1999), which rests on the idea of a direct physical connection in the real world, as opposed to factual causality, which is determining causality by counterfactuals.

Findings

The findings of the study are presented in response to the three research questions outlined earlier.

Impact of OER integration on the use of instructional materials by teachers

Results obtained from the pre-intervention survey of teachers' use of instructional materials (Table 4) indicated use of a range of instructional resources, from print to multimedia and online resources; print-based materials were, however, predominant (100%). Most of the teachers accessed learning material from textbooks (83%) and from the internet (73.5%), as well as from materials created by other professional bodies (65.6%) and from their academic colleagues (57.4%). The data indicate that the teachers' awareness of OER was minimal at the pre-intervention stage, with only 10% having heard the term before. Their awareness of OER was found to be focused mainly on open textbooks (4.3%), multimedia resources (1.7%) and Open Access journals (3.0%). This finding indicated a need to raise awareness of OER among the participants.

Table 4: Teachers' use of instructional materials at the pre-intervention phase

Aspect	Category	Number	Percentage
Heard of OER before	Yes	23	10.0
	No	207	90.0
Used OER before	Yes	9	3.9
	No	221	96.1
Types of OER heard of/used	Open textbooks	10	4.3
	Multimedia resources	4	1.7
	Open Access journals	7	3.0
Format of resources used as instructional materials	Print	230	100.0
	Video	63	27.4
	Audio	42	18.3
	Multimedia	57	24.8
	Online	47	20.4
Sources of instructional materials	Textbook providers	191	83.0
	Professional bodies	151	65.6
	Colleagues	132	57.4
	The internet	169	73.5

The features considered by teachers when selecting educational materials were identified based on their responses to a five-point Likert scale (ranging from "extremely" to "not at all") (Table 5). It was interesting to observe that while the majority of teachers (above 65%) were highly concerned about relevance, informative nature, easy availability, reliability, free access, reusability, cost-effectiveness, attractiveness, easy adoptability, currency of

information and flexibility when selecting educational resources to be used in their teaching, a much smaller percentage (33.9%) were concerned about copyright. This suggests that the teachers were either unaware of or not sensitive to the dimensions of copyright and open licensing, compared to the other features of resources.

Table 5: Features considered by teachers when selecting instructional resources (pre intervention)

Feature	5 (Extremely)		4 (To a large extent)		3 (Somewhat)		2 (To a small extent)		1 (Not at all)		0 (No response)	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Relevant	180	78.3	33	14.3	12	5.2	1	0.4	0	0	4	1.7
Informative	92	40	71	30.9	23	10	16	6.9	10	4.3	18	7.8
Copyrighted	26	11.3	52	22.6	52	22.6	36	15.7	42	18.3	69	30.0
Easily available	135	58.7	51	22.2	26	11.3	6	2.6	1	0.4	11	4.8
Reliable	117	50.9	67	29.1	24	10.4	5	2.2	1	0.4	16	7.0
Freely accessible	104	45.2	64	27.8	36	15.7	20	8.7	6	2.6	0	0
Reusable	101	43.9	54	23.5	43	18.7	12	5.2	4	1.7	16	7.0
Cost-effective	85	40.0	73	31.7	48	20.9	10	4.3	4	1.7	10	4.3
Attractive	115	50.0	66	28.7	35	15.2	2	0.9	0	0	12	5.2
Easily adoptable	104	45.2	72	31.3	32	13.9	19	8.3	1	0.4	2	0.9
Updated	112	48.7	64	27 .8	40	17.4	2	0.9	3	1.3	9	3.9
Flexible	94	40.9	60	26.1	41	17.8	11	4.8	7	3.0	17	7.4

The analysis of teachers' lesson plans also showed that they depended mostly on print textbooks, teacher guides and conventional instructional materials rather than using a variety of learning resources.

After the collection of pre-intervention data, the concept of OER was introduced to the student teachers in a workshop employing the OERTL as a support mechanism. The initial effect of introducing this novel concept into teachers' use of instructional resources is exemplified by the following quotes:

> It is the first time I heard the word Open Educational Resources ... OER is a cost-effective method and easy to search relevant facts according to the subject we want.

> [We] can easily find videos, audio lectures, animations, tutorials, presentations, assignments and assessments about the lessons we wish to find.

> I can understand the meaning OER ... Now I can use useful data and information legally ... Before that I mostly used copyright data and information without permission ... now I can use free usable data sources with permission.

The statements reveal the teachers' interest in the OER concept and their motivation to adopt these resources in teaching and learning. They were highly motivated about having free access to quality educational materials that they could adopt without any legal constraint. They were also happy about the opportunities available to them to translate quality learning materials into the local languages (Sinhala and Tamil) without any restrictions.

Results of the pre-intervention and Phase 1 were useful in planning activities for Phase 2. The need for further capacity development and provision of specific guidance in OER adoption in relation to reusing, revising, remixing, redistribution and retention were identified. In terms of addressing the fact that the English language should not be a barrier for OER adoption, teachers were encouraged and motivated to create OER in local languages.

It was evident from the records in the LMS that the OERTL played a key role in facilitating teachers' access to OER related to their subject areas and their integration of these OER in their lesson plans. The forums also promoted sharing of useful resources among peers.

By mid intervention, patterns in teachers' use of instructional materials (as shown in Figure 4) had changed substantially when compared with pre-intervention data. The majority had developed competencies in searching and identifying OER, identifying CC licensing, the "5Rs", creating OER and integrating OER in their teaching practices.

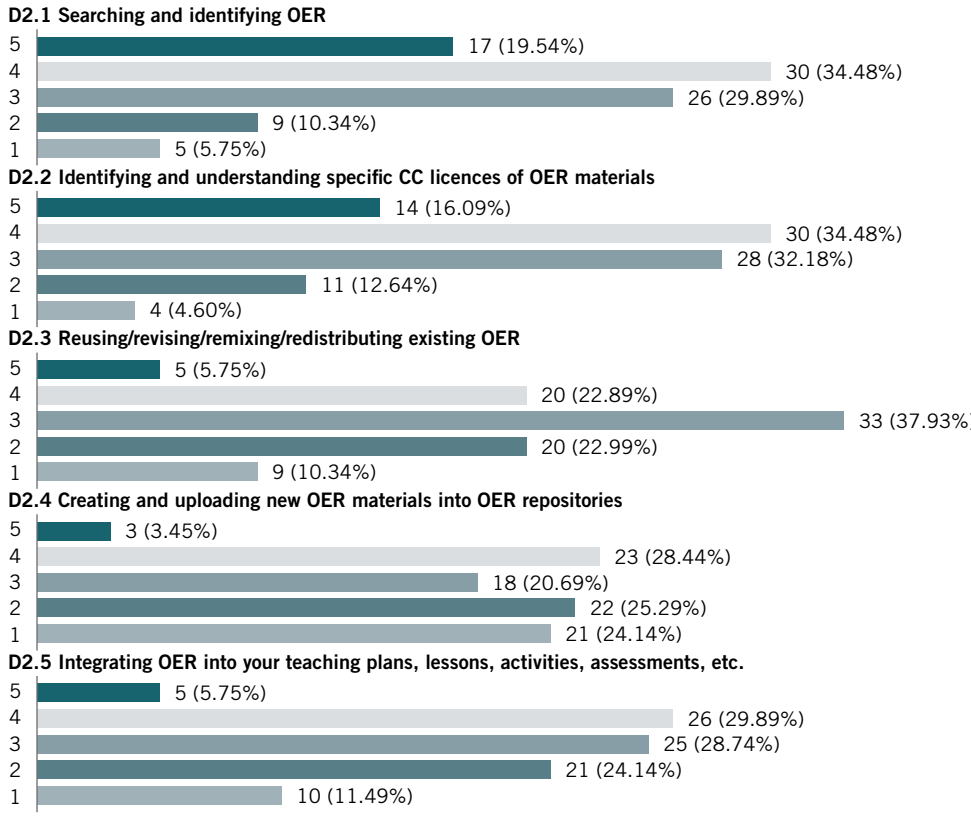

Figure 4: Types of teacher engagement with OER at mid-intervention phase (responses according to five-point Likert scale ranging from 1 "Not at all" to 5 "Extremely")

The majority of teachers (>50%) claimed they had "extremely" or to "a great extent" developed competencies in searching and identifying OER as well as identifying CC licensing. Between 30% and 35% claimed developing "extremely" or to "a great extent" competencies in the "5Rs", creating and integrating OER.

The self-reflective notes of the participants also indicated increased use of OER, despite facing several challenges in the process, such as lack of facilities, language limitations, technical issues and time constraints. The following excerpts provide a sample of participants' reflections:

> Today I found an assessment based on the lesson of "Place value of numbers". Actually it is a very interesting assessment and I hope children will do it freely.

> I could find the information easily using OER.

> I'm interested in OER concept. I have used some OER to my lessons.

By the end of the intervention, as indicated by the LMS records, further increased use of OER by teachers was observed. Science and technology, mathematics and information technology are the subjects where most active use was observed.

Even though the number of participants in many centres had decreased due to various challenges by the end of this stage, a majority of the participants who remained were actively engaged not only in reusing OER, but also in adaptation or revision by translating them into local languages, adapting resources to suit their contexts and even creating OER on their own. This is evident from the following excerpts from self-reflections at the post-intervention stage:

> When I use OER I modify it to local language. Some OER are [more] advanced than I expect. Thus I edit it according to my lesson.

> We were able to find interesting presentations on photosynthesis. We translated one presentation to Sinhala and used it to teach students. Sometimes we downloaded exercises and tests and made copies. Then we distributed among students.

The provision of hands-on experience during the workshops and in the utilisation of the OERTL appeared to vastly support teachers' adoption of OER. The following excerpts from self-reflections at the post-intervention stage demonstrate this:

> Workshop activities helped us to identify relevant OER and identify the nature of their licenses … it helped us to gain some knowledge and practice of the 4R concept through practical activities organised during the workshop.

> We could also access the OER site created for us … in the Moodle LMS and search for OER materials relevant to our subject areas. We could identify appropriate OER to integrate in lesson plans.

It was encouraging to see some teachers' interest grow in terms of creating their own OER in local languages, as well as in English. Exposing teachers to OER motivated them to search, select and integrate OER in lesson plans, which led to enhanced creativity and innovation in their use of instructional resources. While the teachers were highly motivated by having free access to quality educational materials which they could reuse, revise, remix and redistribute without any legal issues, they were also concerned about several challenges, as indicated in the following quotes:

> Use of OER is good opportunity for teachers to develop their teaching-learning process. But, facilities available in school is limited such as internet … If we can use computers in school this is more successful …
>
> It is too time-consuming a process … that searching relevant OER for integrating in the teaching process. But there are many OER …
>
> Because of the language problem it is difficult to integrate in the teaching-learning process. However, I'm trying to create suitable OERs in Tamil. I'll try my level best in this attempt that to create some useful resources.

Lack of adequate ICT skills was a major challenge, and many teachers required support in this area. Limited internet access and connectivity issues as well as lack of IT equipment and facilities in schools were mentioned by many teachers. Even though access to OER was free, bearing the costs of access to the internet was a challenge to individual teachers as well as schools.

Another key challenge faced by the teachers was the language issue, since OER are mostly in English. The majority of teachers were teaching in either Sinhala or Tamil, and had poor or limited English language skills.

Difficulty in finding OER for certain subjects and concerns about their quality, relevance and appropriateness in the local context were some of the other issues identified. The time needed to search and find suitable OER was a key issue due to the teachers' heavy workload. Lack of support or incentives and negative attitudes of school administration were also identified as challenges by some teachers.

Impact of OER integration on teachers' pedagogical perspectives

Teachers' initial perceptions regarding use and sharing of instructional materials were captured in the pre-intervention phase through the survey questionnaire (Table 6). Half of the participants (50.0%) believed that copyright or "ownership" of materials should be with the individual(s) who create the resource, while the next highest percentage (33%) believed it should rest with institutions. A high majority (92.2%) revealed that they share the materials they develop. A high majority (96.1%) also stated that they use learning materials developed by others.

Table 6: Teachers' perceptions regarding sharing of educational materials at pre-intervention phase

Aspect	Category	No.	Percentage
Who should copyright or "ownership" of educational materials reside with?	Individuals	115	50.0
	Institutions	76	33.0
	Publishers	29	12.6
	Not sure	30	13.0
Do you share the educational materials you develop with others?	Yes	212	92.2
	No	18	7.8
Do you use educational materials developed by others?	Yes	221	96.1
	No	9	3.9

Teachers' initial perceptions on "openness in education" were gathered via open-ended survey questions and focus group discussions, as well as through the concept-mapping exercise. As was revealed by responses to the open-ended survey questions, teachers had diverse perceptions regarding the process of freely and openly accessing educational materials developed by others, as well as providing free and open access for anyone to use the educational materials they developed. The positive and negative perceptions of the participants on these aspects (along with the reasons indicated) are presented in Table 7.

Table 7: Teachers' perceptions of the use of free and openly accessible educational materials (pre intervention)

Aspect	Associated perceptions	
	Positive	Negative
Use of freely and openly accessible educational materials, developed by others	"it will save time" "will give innovative ideas" "can get updated knowledge" "sharing knowledge"	Concerns about the "quality", "accuracy", "relevance" and "unfamiliarity of materials" "will need to modify them to suit the requirements"
Sharing educational materials developed by you (giving free and open access to any others)	"sharing is good" "it will help others" "can get feedback to improve" Feel "happy", "satisfied", "proud" and "motivated" when others use my materials	Concerns about "protecting the ownership" "how to maintain identity" "others may not realise the intended purpose of the material"

The majority of respondents were quite positive about using resources developed by others, stating that it would "save time" and provide "innovative ideas" and "updated knowledge". However, there were concerns expressed about the "quality", "accuracy", "relevance" and "unfamiliarity" of materials, as well as the need to "modify" them according to their requirements. That said, almost all participants were willing to share the materials they developed, stating that "sharing is good", "it will help others" and "can [provide] feedback to improve". While most of them felt "happy", "satisfied", "proud" and "motivated" when others used material developed by them, there were concerns about "protecting ownership" and "maintaining identity".

It was encouraging to note that even though the concept of OER was novel to the teachers, they expressed optimistic views about "openness" and its relevance to teaching and learning. Despite certain concerns about reliability, relevance and appropriateness, among others, the teachers were willing to integrate the OER concept in their teaching-learning process.

Concept mapping was used as a diagnostic tool to elicit knowledge structures and understandings of the participants, and to comprehend changes in their pedagogical perspectives. Teachers' initial pedagogical perspectives on "openness in education" were captured through qualitative analysis of the structure and content of their initial concept maps generated in the pre-intervention phase. Analysis of the knowledge structures in the concept maps indicated the occurrence of three morphological types: chains, spokes and nets (Kinchin, 2008). While the majority of morphological types were spoke structures, demonstrating limited or superficial understanding, there were some network structures, signifying a deeper understanding of the concepts. Content analysis of the concept maps revealed that even though the concept of OER was novel to the teachers, their perspectives on "sharing" and "openness" and its relevance to teaching and learning were positive and optimistic (Karunanayaka, Naidu, Kugamoorthy et al., 2015). A more detailed content analysis of these initial concept maps revealed that the majority of teachers understood the concept of openness in education as sharing of knowledge.

A majority of the teach ers focused their attention on teaching-learning resources as a key concept in relation to "openness of education". While a variety of resources familiar to them (such as textbooks, video, audio, teachers' guides, research publications, laboratory instruments, electronic media, as well as many other kinds of online resources) were indicated, very few teachers mentioned OER, confirming that it is a novelty to them. Many did, however, specify factors such as availability, easy access, flexibility, cost-effectiveness, time saving, current information and information sharing as related concepts, indicating their thinking about the significance of such factors in teaching and learning.

Similarly, with regard to teaching-learning practice, teachers identified diverse associated factors, such as obtaining new information, self/independent learning, effective/innovative/creative methods, gaining attention and motivating students, as well as sharing knowledge. While acknowledging these benefits, they also identified various challenges such as lack of facilities and resources, lack of awareness, limited technical and English language skills, cost of internet connectivity, as well as concerns about the quality of materials, time spent and negative attitudes.

A detailed content analysis of the concept maps at the pre-, mid- and post-intervention stages revealed that even though the concept of OER was new to the teachers, their perspectives on "sharing" and "openness" in education and its relevance to teaching and learning were quite optimistic. Despite the fact that a majority of the initial concept maps lacked explanatory phrases and focus in the thinking (as revealed by the structural analysis) and suggested somewhat superficial knowledge on the part of participants, the perspective on sharing and openness revealed in the content analysis is indicative of an overall positive perspective on the part of the teachers.

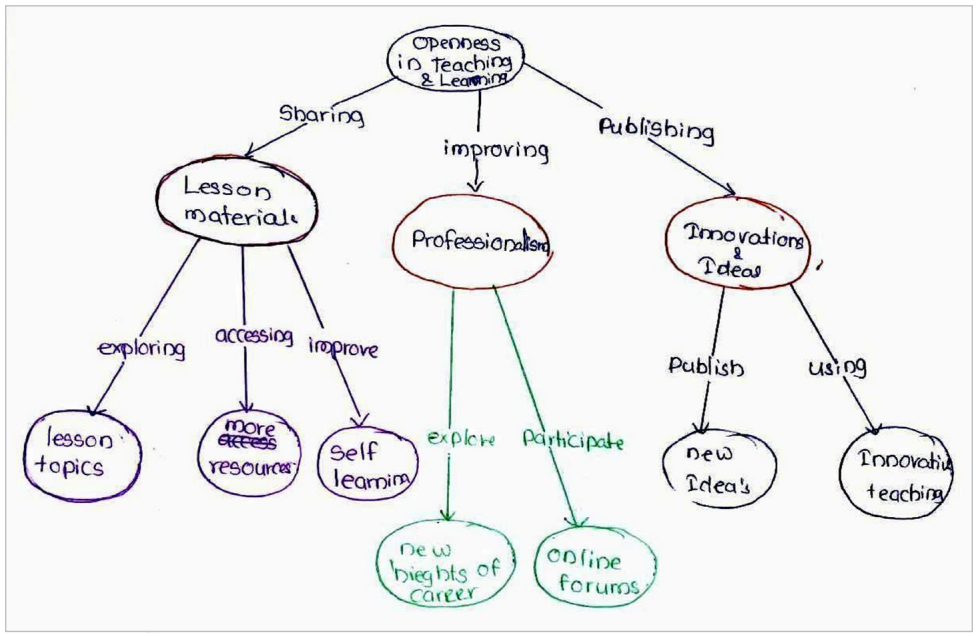

Figure 5: **Pre-intervention version of a teacher's concept map**

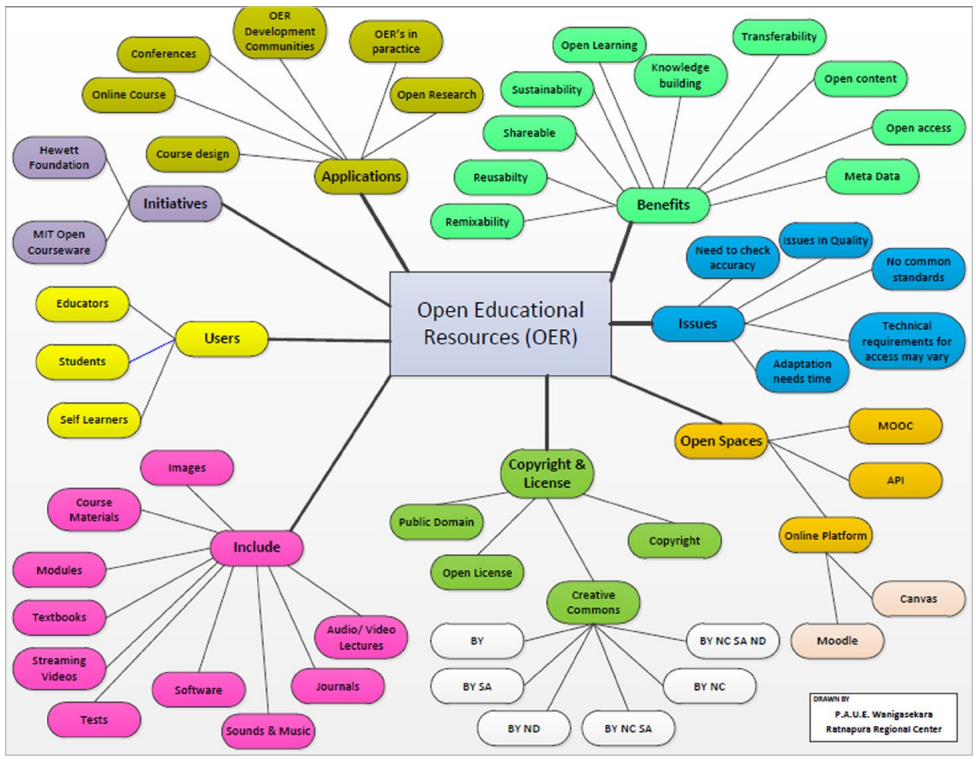

Figure 6: **Post-intervention version of a teacher's concept map**

Comparison of different versions of concept maps drawn by the teachers at different stages of the intervention revealed incremental developments and changes in their understandings and thinking around concepts in relation to openness in education and OER over time, as illustrated by Figures 5 and 6. For instance, at the initial stage, the concept maps were very simple and included only a few concepts and links (Figure 5), whereas the concept maps generated in the post-intervention phase were more complex, with many concepts and links depicted (Figure 6).

By the end of the intervention all participants claimed that they were prepared to face challenges and integrate the concepts of sharing and openness in their teaching and learning. The following statements from participants support this observation:

> We should update our knowledge on these concepts … and make the teaching-learning process more efficient and effective.
>
> As a teacher, I am eager to adapt myself towards any positive change that will reinforce my students' learning.
>
> Through the integration of OER … we have got the opportunity to "think out of the box" ... The creation of our own OER enhanced our thinking capabilities.

These results indicated a change in the teachers' pedagogical perspectives towards more openness in education.

Impact of OER integration on teachers' pedagogical practices

Analysis of the teachers' pedagogical practices through checklist data before the intervention revealed that the majority (60%–70%) demonstrated constructive alignment between learning outcomes, activities and assessments; the use of a learner-centred pedagogic approach; opportunities for knowledge construction; a variety of learning activities; opportunities for interaction; and evidence of a sharing culture. Yet, at the same time, only a very small percentage (10%–20%) demonstrated innovative learning design and creative use of instructional resources through a variety of media types, use of technology, creation of an enjoyable learning experience, promotion of self-directed/self-regulated learning, opportunities for learner creativity, opportunities for application of knowledge, links with real-life situations, and catering to different learning styles. Further, none of the participants demonstrated use of online resources or OER. These findings affirmed the results obtained from the questionnaire survey and focus group discussions.

However, by mid intervention (as shown in Figure 4), it was evident that from an initial state of "no usage" at the pre-intervention stage, participants were gradually moving towards adopting OER through "reuse", integrating these resources in their teaching-learning methods. The gradual changes in pedagogical practice were revealed in teachers' self-reflective notes, as the following excerpts demonstrate:

> I used OER several times and one lesson plan is uploaded … Some activities are helpful to increase the efficiency of the learning process.
>
> I have reused OER for my lessons so far and [am] trying to remix them further.

It was observed that teachers have not only continued with searching, finding and integrating OER into their lesson plans, but also sharing them with others.

At the end of the intervention, during the evaluation workshops titled "Tell us your story: Becoming reflective practitioners" held at each of the nine OUSL centres, self-reflective narratives were written in the form of "stories" by the 85 participants who were still part of the intervention. Narrative analysis of 22 of the stories written by these teachers was conducted using thematic analysis, coding and categorisation of various aspects of the accounts (Riessman, 2005) in order to discover patterns and develop themes. These were then organised using the Rolfe et al. (2001) framework ("What?", "Now what?" and "So what?"), providing a possible causal link between ideas. This process helped to ascertain the changes that had occurred in the pedagogical thinking and practices of teachers. Specifically, it was observed that exposure to the concept of OER resulted in the development of teachers' knowledge and skills in searching, identifying and integrating OER in their teaching-learning process, and provided them with a range of new insights and some innovative practices. The identification and description of activities, self-analysis of teachers' feelings, and discussion of the effects of their actions in relation to OER integration led the teachers to consider formulating action plans for the future.

For the student teachers in this study, awareness of OER and access to a free and open pool of varied resources with legal permission to reuse, revise, remix, redistribute and retain these resources resulted in a change in their thinking and practice from traditional methods of teaching and resource use, enhancing creativity, innovative thinking and a sharing culture. There were many examples of teachers sharing OER and spreading the OER concept among their students and peer teachers through self-created booklets, handouts and awareness-raising workshops. Such changes in practices are supported by the following statements made in focus group discussions and self-reflective narratives:

> I created more than 30 OER and uploaded to [the] LMS and also searched and found more than 50 lessons to different subjects.
>
> We felt proud to publish a magazine on OER titled "Integrating OER in Learning Teaching Process".
>
> I shared my OER knowledge with my school teachers by organising a workshop.

Figure 7 shows an example of OER created by a group of participating teachers, which was shared with students and teachers at their school as well as at other schools.

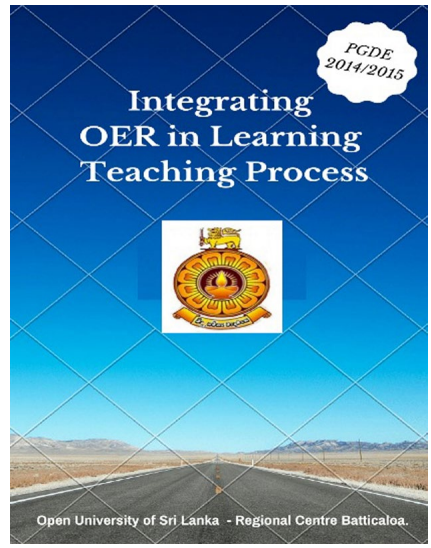

Figure 7: Example of an OER created and shared by participating teachers

These findings reveal that the teachers were challenged, encouraged and motivated to engage in the integration of OER in their future teaching-learning practice in a more productive manner.

Discussion and concluding remarks

The impact of OER integration on teachers' pedagogical practices and perspectives in this study was observed along three dimensions: their use of new or revised instructional materials, changes in their beliefs and use of new teaching approaches.

From an initial state of "no usage" or "minimal usage" of OER, participants in the study moved towards increased adoption of OER and OEP in their professional practice. Wiley's "5Rs" permissions framework associated with OER empowered teachers to move from "low" to "high" degrees of use and creation of instructional resources. Findings confirm that engagement with OER in terms of adopting the "5Rs" stimulated critical reflection among the teachers with regard to their current pedagogical practices, and also supported a shift towards a participatory and sharing culture in their practice. This included notable changes in their pedagogical practices towards a more context-centric approach. Evidence of such use, creation and management of OER via innovative pedagogical methods illustrates how the integration of OER has impacted pedagogical thinking and practices among teachers, leading to OEP.

Challenges included lack of knowledge, limited skill sets, time constraints, technical barriers and cultural obstacles. However, once introduced, teachers' appreciation and willingness to embrace OER, as well as their positive attitudes towards a sharing culture, allowed them to progressively move forward, overcoming the challenges.

This study demonstrated how a carefully structured enabling environment with strategic, systematic design of meaningful learning experiences can be used to support and facilitate the adoption of OER and OEP by teachers (see also Karunanayaka et al., 2016; Naidu & Karunanayaka, 2014; 2015). The intervention implemented during the study used several strategies to design effective, efficient, engaging learning experiences with OER integration, following tested frameworks (Ehlers, 2011; Naidu & Karunanayaka, 2014). The specific strategies of the intervention, which were designed based on situated learning principles, were constantly refined during the process based on participants' and researchers' experiences and reflections.

The process of OER integration in teaching-learning, including evaluating of its impact, was supported with the use of a design-based approach where problems were addressed by the researchers in real-world contexts in collaboration with practitioners (teachers). During this iterative process, existing design principles were integrated with technology to find possible solutions to problems related to the teaching-learning process, while researchers and practitioners engaged in reflective enquiry and defined new design principles (DBR Collective, 2003; Reeves, 2006). This process resulted in the creation of an enhanced conceptual framework in the adoption of OEP in terms of instructional resource use, pedagogical perspectives and pedagogical practices (see Karunanayaka & Naidu, 2017).

The experiences in the intervention which were based on situated learning principles included specific strategies that were designed to support teachers' move from low to high degrees of context-centric, challenging, critical, creative and collaborative thinking and practices. Altogether, these strategies contributed to changes in teachers' instructional resource use, pedagogical perspectives and pedagogical practices towards OEP.

This study has shown that careful design of OER integration is crucial for its adoption by teachers. The availability of OER helped teachers become more productive professionals. Teachers were able to engage in flexible and dynamic knowledge creation, which also provided a cost-effective way to develop and share quality teaching-learning materials.

Various inhibiting factors and challenges faced by participating teachers – similar to those identified by Hatakka (2009) and Karunanayaka and Naidu (2014) – meant that there was a decrease in the total number of active participants by the end of the intervention. However, the motivation to overcome such challenges and attempts at integrating "open" concepts in their pedagogical practices by the participants who remained active was a very prominent feature. Collaborative attempts at OER adoption, creation and sharing among teachers, with the involvement of students, was particularly noteworthy. These changes enhanced innovations in the teachers' use and creation of teaching-learning resources.

This kind of capacity-building of teachers in OER adoption has the potential to strengthen the school education system in Sri Lanka. Motivating teachers through providing further opportunities, and recognising their initiatives through incentives and appreciation, would empower teachers to act as "change agents". It would also provide insights to inform recommendations for the formulation of evidence-based guidelines to support OER adoption.

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