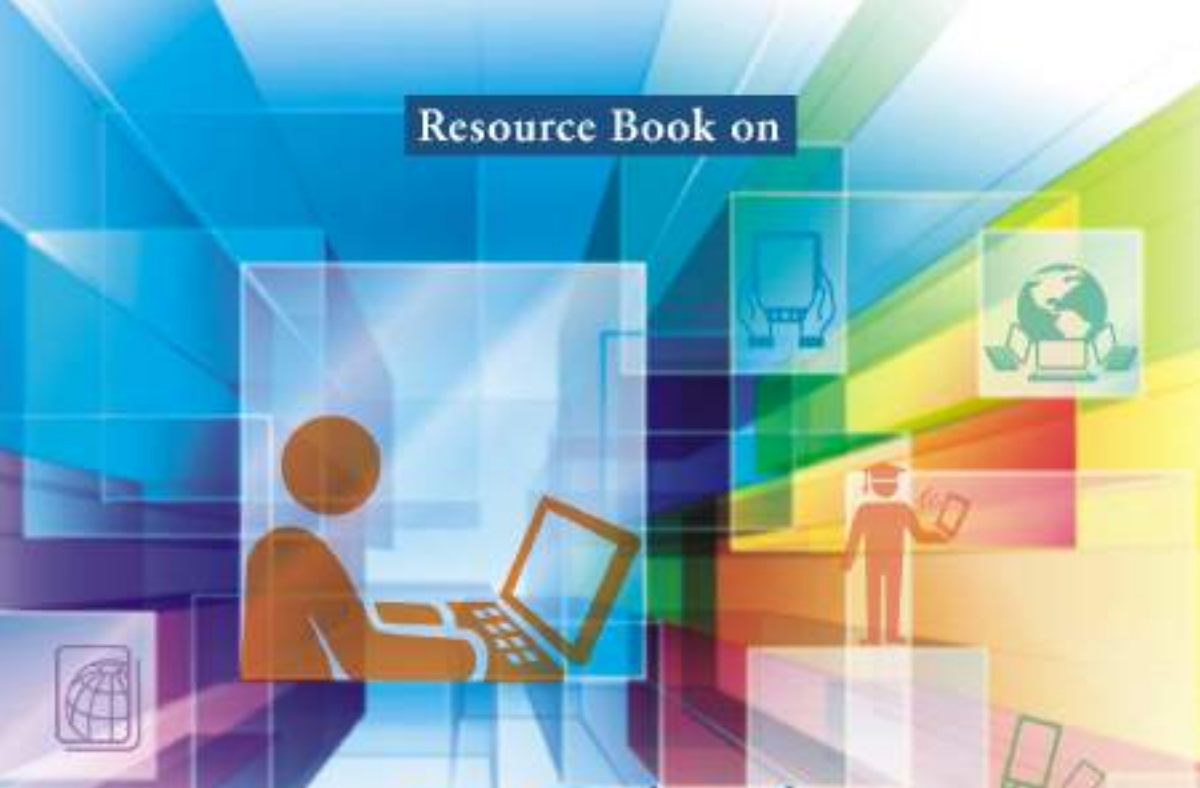
Resource Book on



ICT

Integrated Teacher Education

Edited by

Manas Ranjan Panigrahi

Commonwealth Educational Media Centre for Asia

Resource Book on

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Commonwealth Educational Media Centre for Asia
New Delhi

The Commonwealth Educational Media Centre for Asia (CEMCA) is an international organization established by the Commonwealth of Learning (COL), Vancouver, Canada, to promote the meaningful, relevant and appropriate use of ICTs to serve the educational and training needs of Commonwealth member states of Asia. CEMCA receives diplomatic privileges and immunities in India under section 3 of the United Nations (privileges and immunities) Act, 1947.

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For further information, contact:
Commonwealth Educational Media Centre for Asia
7/8, Sarv Priya Vihar
New Delhi - 110016
http://www.cemca.org.in

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Contents

Preface

Integration of Information and Communication Technologies (ICTs) in teacher education is a mean to support high quality teaching and learning, involving teacher educators, teachers, student teachers, and leaders. It requires how best to explore utilization of technologies for meaningful learning of students. In the present digital world students must be given opportunities to learn with effective and efficient integration of ICTs in the classroom. Integrating Information and Communication Technologies (ICTs) in education is highly challenging, especially in the teacher education sector. While there are several factors for successful integration of ICTs in teaching and learning, professional development of teacher educators, strong leadership support and institutional commitment play significant role. With this background the Commonwealth Educational Media Centre for Asia (CEMCA) initiated a programme "***Adoption of Blended Approach to ICT Integration in Continuous Professional Development of Teacher Educators***" to engage with teacher educators in India over the three years during the period 2013-2015. In the process several events were organised in different states of India for District Institute of Education and Training (DIET) teacher educators to develop capacity on ICT integration inteaching and learning, and sensitize them about the building of a Community of Practice (CoP).

There are five chapters included in this resource book as ICT Integrated Teacher Education Models for wider dissemination with the hope that teacher education institutions and organisations in Commonwealth Asia will take steps to develop strategic plans for ICT use in teaching and learning. Chapter I: *Trends and Challenges in ICT Integrated Teacher Education in Commonwealth Asia* discusses different aspects of integration of ICTs in teacher education programmes and also identifies barriers and challenges to technology integration. It highlights criteria of integration of technologies for learning of students; and teachers desire to integrate ICT in to education. Understanding the means of integration of ICTs in teacher education, its strength and function is important. Chapter II: *The Technological Pedagogical Content Knowledge Framework for Teachers and Teacher Educators* focuses on teacher educators need to visualize ICT integration in a holistic manner, and the authors in this chapter present the highly popular framework – TPACK forthe readers to consider. It is important to note why adoption of a framework is important to consider

ICT integration in teacher education. They argue that good teaching with technology requires shift in existing practices in both pedagogy and content domains. Teacher educators are therefore urged to think about their own context, and go beyond technology literacy to promote educational practices that innovatively use interaction of technology, pedagogy and content. Chapter III: *Using UNESCO's ICT Competency Framework for Teachers in Guyana*, the authors present a detailed description of the implementation of the UNECO ICT Competency Framework as a model of teacher professional development in Guyana, and highlight the processes undertaken, lessons learnt, and cost-effectiveness of the use of OER in developing the learning materials. While the approach has been successful, readers areexpected to critically analyse and review the suitability of such a practice in their own context, especially for the decision-makers to develop strategy to implement ICT integration in teacher training, and for teacher educators to rethink theuse of UNESCO ICT CFT. Chapter IV: *Technology, Education and Design: The Sciences of the Artificial* reflects that the design of effective, efficient and engaging learning and teaching experiences is the product of synergies derived from knowledge about the technology, pedagogy and the subject matter. It includes knowledge about the affordances of each attribute, as well as knowledge that lie at the intersections of these three variables. More recently dubbed as technological pedagogical content knowledge by Mishra and Koehler, this is an idea that extends Lee Shulman's concept of pedagogical content knowledge to include knowledge about the technology (i.e., the media), and the content (i.e. subject matter that is to be learned and taught). At the heart of synergies derived from this kind of knowledge is design which is a science of the artificial, as opposed to a natural science. And this is about creating and orchestrating how productive learning and teaching experiences ought to be. The ideas that are articulated in this chapter will resonate with teachers and teacher educators as they search for ways to integrate ICTs in their teaching and learning activities. Chapter V: *Teleconference Based model of Capacity Building for ICT Integration* describes the use of tele-conferencing and video conferencing models in professional development of teachers. These modes brought proliferation ofinnovative means for professional development of teachers. Author also explains that, how EDUSATis used effectively and successfully for training of in-service teachers overcoming the issues of access, quality and transmission lossunder *Sarve Shiksha Abhiyan* (SSA) in India with which the conventional professional development models suffer. It addresses the challenges of providing quality training to the millions of teachers of the country especially in rural, hilly and remote areas where conventional systems could not reached effectively.

The chapters in this publication will assist informed educational leaders, teacher educators, teachers in teacher education and school education to drive implementation of technology plan and integration of ICTs in teaching and learning.

I take this opportunity to thank all the DIET teacher educators, educational leaders who participated in the professional development events organised by CEMCA. I also thank to all partners and collaborators viz. DSERT-Karnataka; SCERT-Uttar Pradesh, Madhya Pradesh, Himachal Pradesh; IT for Change-Bengaluru; RIE-Bhopal and Mysore (NCERT); Central University of Himachal Pradesh; Allahabad University for hosting the events and supporting for successfully implementation of the ICT Integration in Teacher Education. I remain indebted to Dr. Sanjaya Mishra and Dr. Ramesh C. Sharma, former Director CEMCA for their support, motivation and valuable advice to improve and completion of this work. Special thanks are also due to all the contributors for their acceptance to include their work in this resource book. As always, we look forward to receiving your comments and suggestions for improving our work at CEMCA.

Manas Ranjan Panigrahi (Ph.D)
Programme Officer (Education)
Commonwealth Educational Media centre for Asia
New Delhi

CHAPTER - 1

Trends and Challenges in ICT Intergrated Teacher Education in Commonwealth Asia

Manoj Kumar Dash

Introduction

Research and development in pedagogical practices has shown improved model of instructional design for meaningful learning of students. Integration of Information and Communication Technologies (ICTs) and their integration in teacher education programmes are a means to improve and reinforce the quality of teacher education programmes at pre-service and in-service level (Dash, 2014). In the 21st century, technology is considered to be a potential instrument for bringing revolution in social and cultural lives of our society. However, the teacher education institutions and teacher education professions in our country and in all Asian countries are yet to explore its complete advantages (Mishra, et al., 2006). Capitalizing the potential of new technologies in general and digital technology in particular as a learning tool for effective teaching learning process is the real need in today's world. What essentially the need of the time is meaningful integration of technology with curriculum and teaching–learning process to bring about to learners the shared learning resources and learning spaces, promotion of collaborative learning, leading to a move towards autonomous learning.

Technology Mediated Approaches to Teaching–Learning

With implementation of ICTs and its effective integration with teaching-learning process, the approaches to learning and teaching has been changed

dramatically (Takwale, et al., 2014). The basic approaches are as follows:

- Learner Centric: Explore the best in every student.
- Learning Centric: Learner learn by designing and preparing meaningful learning experience with the help of a teacher.
- Promoting Inquisitiveness: Develop questioning ability in learner. Teacher encourages learner to ask questions. It leads to critical thinking.
- Innovation Centric: Teacher promotes innovation, creativity and team spirit in learner.
- Develop cooperative and collaborative learning environment: Learning occurs through discussion, interaction and debate called learning for development.

Teacher is expected to perform the role of a facilitator and moderator with different responsibilities in different situations in a technology-mediated learning environment, called networked society. There is the need for specialized training and orientation of teachers to enable the teacher to develop the classroom, school and society with new skills and competencies.

Open Education Resources for Teacher Development

Two significant developments such as Open Educational Resources (OERs) and integration of ICTs have created major changes in the field of teacher education. The impact of these two developments has quantized on the basis of how they complement each other. With these two developments education can be provided to one and all as per their needs and convenience in spite of the complexity of the learning situation in terms of number, heterogeneity, authenticity and difference in learning abilities. OERs are digital materials that can be used, reused for teaching, learning and research, and made available for free (Menon, 2014). It includes a variety of multimedia learning content such as books, course materials, content modules, learning objects, collections and journals. OER movement is quite rapid in today's world. There are several OER sites that allow networking of institutions and individuals who are supporting the creation and sharing of multimedia courseware. At the same time, these institutions are committed to capacity building of individuals for creation of OER and its integration. Some of the important OER sites are as follows:

- MIT Open Course Ware (OCW) is a web-based publication open and available to the world: http://ocw.mit.edu/index/htm
- The Open Course Ware Consortium: http://www.ocwconsortium.org/

  [There are 18 sustaining members in this consortium today. African Virtual University which has developed resources for in-service teacher training is a member of this consortium.]
- OER Asia is an online forum set up by Wawasan Open University: http://oerasia.org/
- Teacher Education in Sub-Saharan Africa (TESSA) is a research and development initiative creating OERs and course design guidance for teachers and teacher educators working in sub-Saharan African countries. TESSA produced large bank of materials that focused on classroom practices. The materials are available in variety of formats and languages and are downloadable: http://www.tessafrica.net/
- COL Resourses: There are a number of learning and training materials that are expected to be free for use. There are some third party resources which are bound by the copyright conditions. These could be used with written permission from the organization concerned. There is a large volune of resources on COL websites in the area of teacher training: http://www.col.org/resources/

Most of the teacher education curriculums are with a theory-driven approach with an assumption that it would equip the teacher to deal with the complexities of the real situation.

ICTs and Learning Management System

The present system of offering teacher education programme needs to be enhanced by adopting technology-enhanced learning and effective management practices. All the teacher education institutions should have their own virtual learning environment as a single entry portal for information to the public as well as regulated access for all students, teachers and other staff as open learning environment. This can be made technologically inclusive as it would support diverse ways of reaching and engaging the learners-internet, TV, Mobile, community radio, Internet Radio, IP-TV and many more. It would be pedagogically inclusive as we can imbed chosen pedagogic structure in the form of open course guide (Srivathsan, 2010). The functional component course management and study plan can also be introduced. With this, all the educational activities

can be monitored, regulated, that too with assurance to students. Teacher education institutions should offer well-managed and assured quality of education to all students using ICTs. There is a need to understand and appreciate the kind of technology-mediated processes in which the learners are to be immersed in a quality education system.

Technology-Mediated Learning: Social Impact

ICTs have the capabilities to bring several benefits to teachers and students such as shared learning resources, shared learning spaces and promotion of cooperative and collaborative learning they also provide a base for autonomous learning. ICTs have enabled us to communicate one to one, one to many and many to many through communication channels and networking. They provides a means to organize institutions differently and lead to new ways of working together with virtualization. With implementation and integration of ICTs in teacher education, the society has been transformed into a knowledge society. The major challenge before us is how to transform the curriculum and teaching–learning process to enable students to function effectively in this changing world. Our responsibility is to meet the challenges of future and empower our children to learn through technology (Chaudhary and Garg, 2005). Use of technology and its effective integration with curriculum have become inevitable in the present age of ICTs.

With the emergence of technology in the field of teacher education, the role of teacher is not just confined to teaching alone. Teacher is expected to be a facilitator and moderator in the whole teaching–learning process. The key features with reference to changing roles of teacher in the classrooms are as follows:

- Learners have access to networked resources on which teacher is presenting information; as a result the use of overhead projectors and chalkboards becomes obsolete.
- With the use of online tests some of the traditional assessment methods become redundant.
- It is important for the teacher to encourage critical thinking skills of students, promote information literacy and nurture collaborative practices not just to impart content knowledge.
- Teacher is expected to identify quality information from

misinformation. Therefore, the new role of teacher is identification, classification, and authentification of electronic information sources.

- Recurrent training and professional development of teacher is important to ensure optimal use of technology and its effective and efficient use in classrooms.
- Teacher needs to transform the classroom to a place of dynamic student centred learning environment in which student interact with peers in their own classroom and with virtual classes around the world.

ICTs and their effective integration can motivate students and teachers in one hand and also can make a classroom more interactive learning environment on the other hand (Garg and Chaudhary, 2006). With this, there will be no barriers between teachers and students in the classroom.

Means for ICT-Enabled Teacher Education

In the field of teacher education ICT-based applications and their integration with content, method and pedagogy are potential catalysts for meaningful learning of students. Professionals associated with teacher education institutions should equip them to design their educational system and prepare teachers for the future of the society (Singh, 2014). Some of the important strategies to make ICT-enabled teacher education programme a real success are:

- Teachers must update their knowledge and skills to use the digital technology in classroom for teaching–learning process.
- Teacher education institutions should be equipped with ICT-based resources with provision of training and orientation of teacher educator for better integration of technology with content and pedagogy.
- Professional competencies to integrate ICTs into teaching and learning process are a continuous process to ensure meaningful participation and integration of students.
- Educational administrators and policy makers should work more closely with schools and colleges to determine the training needs of teachers and extend their support to organize appropriate training programmes with better exposure at all levels.
- In-service and pre-service training should involve use of ICTs in

pedagogical analysis, presentation of content with new techniques of evaluation.

- Teachers at all levels of education need to be supported in meeting the challenges of effective integration of ICTs for improving classroom practices. All the classrooms should also be equipped with basic ICT - based infrastructure like computers, projector and internet facility.
- Teacher in education institution should have well equipped ICT Lab with computer, satellite communication, high-speed internet facility and other electronic media to supplement the learning of children in this digital world.
- Discipline-wise (e.g., mathematics, language, science, EVS) short-term ICT-based programme should be designed for teacher educators and teachers as a part of their professional development.
- Motivation of teachers leading to their active participation is very important for result-oriented initiatives and their implementation. Incentives like certification, professional advancement, formal and informal recognition at the institution and community levels are some of the means to sustain motivation of the teachers and teacher educators.
- Curriculum and course content should be designed with an approach to ensure better implementation of ICTs and should be supported by technology-mediated Learning Management System (LMS). The curriculum and content of teacher education should enable the students to compete globally. This is possible by developing a pool of world-class content and designing the content with socially relevant examples and illustrations through technology-mediated interventions for students.
- Teacher education institutions across the country must provide the leadership for pre and in-service teachers and model the new pedagogies and tools for learning with active collaboration from national and international agencies. With mutual collaboration from all around it would be easy and convenient to design and develop culturally responsive digital content for teachers and students.

Issues in Implementation of Technology-Mediated Teacher Education Initiatives

Creating a cadre of teacher educators at different levels who are able to

appreciate the initiatives of technology-mediated learning is very important through research and development in the field of teacher education in all the Asian countries. They must appreciate blended learning and paced learning to develop a motivation for effective integration of technology with content of teacher education curriculum (Senapaty, 2005). It is imperative to consider the global standard and set a benchmark to correlate their performance with the performance of global standards. Some of the common issues in integration of ICTs in the field of teacher education are as follows:

- A well designed technology-mediated teacher education curriculum with appropriate mechanism of assessing and monitoring quality of education should be in place for ensuring better implementation of integrated teacher education programmes.
- Availabilities of technical capabilities are one of the issues in making course design and its production for technology-mediated learning.
- Policy planning is very important to have outcome-oriented plans, programmes and interventions for the effective use of ICTs in teacher education programme. It is found that there is a lack of coherence in planning and leadership which consequently affects the implementation aspect.
- It is essential to bridge the gap between the mind set-up of new-age students and old classroom teachers through advocacy and in-service training and capacity-building activities from time to time.
- Availability and accessibility of technology should be made cost-effective for users at all levels.

The Challenges in ICT-Integrated Teacher Education

The teacher education institutions should understand the tremendous potential of digital technologies and how best it can be harnessed in teaching–learning process to enable the students to learn meaningfully. With this teacher education institutions can really serve different segments of the society and meet the expectations of the new generation learners (Panda and Basantia, 2005). Making teachers familiar with emerging technologies is also very important.

- Teacher education institutions find it difficult to collaborate on the development and implementation of ICT courses for pre-service and in-service teachers with agencies within their reach.
- Teachers face major challenges when they are in schools due to number of demands and expectations. At the same time, they are expected to be innovative in the use of ICTs in classroom teaching–learning process.
- The effective integration of ICTs for meaningful learning need to be constantly updated to make then current, relevant and pedagogically sound.
- The course content must be constantly revised and updated as the technology is moving fast from time to time. It is essential to make the content in line with new trends in learning with technology. For example, Mobile can be used as a learning device in view of its accessibility, cost-effectiveness and ease of operation.
- Teacher education institutions should aim to capture the potentials and opportunities available to enable students to access their course materials and work collaboratively. The future of using technology for teaching and learning is always challenging. Therefore, it is imperative for teacher educators to update themselves with recurrent training and orientation through refresher courses and orientation programmes.
- A major challenge is lack of initiative on the part of formulation of appropriate policy to encourage teachers and teacher educators to incorporate the use of technology in teaching.
- Content-wise identification of activities is one of the significant challenges in the development of the courseware for effective integration. Real challenge is in providing guidance to student teachers and in following up their work from time to time.

Some of the other common challenges in Asian countries pertaining effective integration of ICTs in teacher education programmes are summarized as follows:

1. Issues of poor connectivity in rural and remote areas that are inaccessible.
2. Lack of improvised need-based and localized courseware for capacity building of teacher educators, trainers, teachers and students at different levels.
3. Major focus in pedagogical practices is to complete the syllabus

through print materials and there is a lack of emphasis on ICT-based materials.

4. Lack of integration of ICT-based materials with curriculum and course design and course planning.
5. Inadequate training and capacity building process for teachers, teacher educators, administrators and policy planners at different levels.
6. Schools located in rural and semi-urban areas face difficulties in supply of electricity.
7. Maintenance of hardware in school-level is another grey area for ensuring better implementation of technology and integration of technology.
8. Inappropriate feedback mechanism from various formal & informal sources for continuous improvement of technology-mediated practices.
9. Developing research base to manage innovations are prerequisite for sustainable development in integration of ICTs (UNESCO, 2002). It is essential to provide guidance about how to integrate ICTs into teacher education and suggest important strategies on conditions that leads to successful implementation of ICTs in teacher education system.
10. Teacher education institutions need to change their nature and structure in the context of integration of ICTs in teacher education curriculum. A web-based training environment requires all aspects to be completely revamped.
11. One can learn at any time of his/her choice within 24 hours in a day. However, the present systems do not allow this. A web-based training environment enables the learner to learn at any time.
12. Design and development of an appropriate curriculum keeping in view the people who will function in a globalised environment and the information age (Srivathsan, 2010). At the same time, global knowledge and global resources must be kept in mind while framing curriculum for teacher education programmes.

Conclusion

Technology has created a change in all dimensions across the globe. Effective and efficient integration of ICTs into the system of teacher education is a highly complex process and its success demands team work to fulfil its mission and vision. There is no doubt that allocation of adequate financial

resources, qualified and trained human recourses and supporting educational policies are some of the important prerequisites to have outcome oriented integrated teacher education programmes. Over a period, it is learnt that integrated teacher education initiatives brought more learning resources to the classroom. This subsequently is a means of learning for the teachers and the students also. Effective implementation of ICTs is certainly a powerful means of improving quality of education in general and teacher education in particular. The new technologies and their effective integration with curriculum and classroom processes have enormous potential to revolutionize teacher education at all levels. Therefore, ICTs are an important tool in the new paradigm of learning. It is essential to capitalize the new technologies, particularly the digital technology by professional development of teachers. Construction of professional knowledge about content, pedagogy and technology is very important for all teachers. This is achieved by providing appropriate learning experiences to teachers through digital technology. Teacher education institutions must create an environment for teachers to enable them to create appropriate learning experiences for students in the new age of learning.

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CHAPTER - 2

The Technological Pedagogical Content Knowledge Framework for Teachers and Teacher Educators

Matthew J. Koehler, Punya Mishra, Mete Akcaoglu & Joshua M. Rosenberg

Introduction

The Technological Pedagogical Content Knowledge (TPACK) framework (Koehler & Mishra, 2008; Mishra & Koehler, 2006) describes the type of teacher knowledge required to teach effectively with technology. Describing what teachers need to know can be difficult because teaching is an inherently complex, multifaceted activity that occurs in varied settings. By its nature, teaching is an ill-structured problem (Leinhardt & Greeno, 1986; Spiro, Coulson, Feltovich, & Anderson, 1988) requiring reasoning about a wide range of interrelated variables such as the background knowledge that students bring into the classroom, teacher and student expectations about the content to be covered, and school and classroom guidelines and rules. The use of technology in the classroom introduces a new set of variables into the teaching context, and adds complexity due to its rapidly-changing nature (Koehler & Mishra, 2008). The TPACK framework identifies a unifying structure that not only respects this complexity, but also provides guidance for appropriate technology integration (Koehler & Mishra, 2008; Mishra & Koehler, 2006).

The TPACK framework describes the kinds of knowledge that teachers need in order to teach with technology, and the complex ways in which these bodies of knowledge interact with one another. This builds on the approach used by Shulman's (1986) pedagogical content knowledge (PCK), describing how and why teacher knowledge of pedagogy and content

cannot be considered solely in isolation. Teachers, according to Shulman, need to master the interaction between pedagogy and content in order to implement strategies that help students to fully understand content. The TPACK framework extends Shulman's (1986) notion of PCK by including knowledge of technology.

Teachers must understand how technology, pedagogy, and content interrelate, and create a form of knowledge that goes beyond the three separate knowledge bases. Teaching with technology requires a flexible framework that explains how rapidly-changing protean technologies may be effectively integrated with a range of pedagogical approaches and content areas.

Please note that this paper is only a brief summary of the TPACK framework and related ideas. Interested readers may wish to reference more in-depth prior work (e.g., Koehler & Mishra, 2008; Mishra & Koehler, 2006) or by visiting tpack.org.

Overview of TPACK Framework

In the TPACK framework, what teachers need to know is characterised by three broad knowledge bases – technology, pedagogy, and content – and the interactions between and among these knowledge bases. In this approach, technology in teaching is characterised as something well beyond isolated knowledge of specific hardware or software. Rather, technology

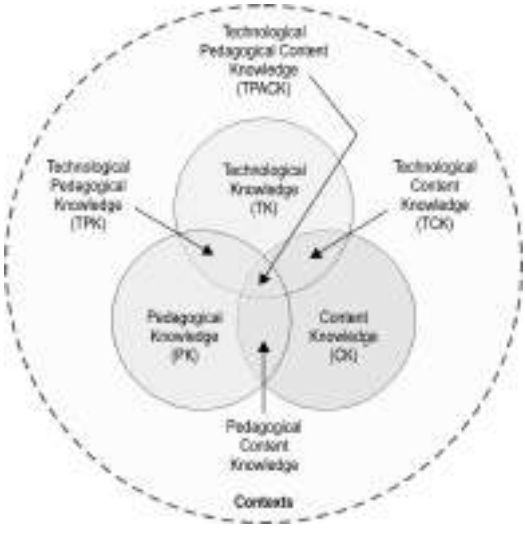

Figure 1. *TPACK Framework (Image from http://tpack.org)*

that is introduced into teaching contexts "causes the representation of new concepts and requires developing a sensitivity to the dynamic, transactional relationship between all three components" (Koehler & Mishra, 2005a, p. 134). Good teaching with technology, therefore, *cannot* be achieved by simply adding a new piece of technology upon existing structures. Good teaching, with technology, requires a shift in existing pedagogical and content domains.

The TPACK framework also emphasises the role of the context within teaching and learning. Ignoring context leads to "generic solutions to the problem of teaching" (Mishra & Koehler, 2006, p. 1032). Teaching is a context-bound activity, and teachers with developed TPACK use technology to design learning experiences tailored for specific pedagogies, crafted for specific content, as instantiated in specific learning contexts. In the sections below we describe each of the components of the TPACK framework and, most importantly, their interactions with each other.

Technological Knowledge (TK)

TK includes an understanding of how to use computer software and hardware, presentation tools such as document presenters and projects, and other technologies used in educational contexts. Most importantly, TK covers the ability to adapt to and learn new technologies. It is important to note that TK exists in a state of flux, due to the rapid rate of change in technology (Mishra, Koehler & Kereluik, 2009) and due to the protean nature of technology (Koehler & Mishra, 2008). For instance, modern computer hardware and software become quickly obsolete, and computers can be used for a variety of pedagogical tasks, such as research, communication, and media consumption and creation.

Content Knowledge (CK)

CK refers to the knowledge or specific nature of a discipline or subject matter. CK varies greatly between different educational contexts (e.g., the differences between the content of primary school math and graduate school math), and teachers are expected to master the content they teach. Content knowledge is also important because it determines the discipline-specific modes of thinking unique to each field.

Pedagogical Knowledge (PK)

PK describes the "general purpose" knowledge unique to teaching. It is the

set of skills that teachers must develop in order to manage and organize teaching and learning activities for intended learning outcomes. This knowledge involves, but is not limited to, an understanding of classroom management activities, the role of student motivation, lesson planning, and assessment of learning. PK may also describe knowledge of different teaching methods, such as knowing how to organise activities in a way conducive to students' constructive building of knowledge.

Pedagogical Content Knowledge (PCK)

PCK reflects Shulman's (1986) assertion that effective teaching requires more than separate understanding of content and pedagogy. PCK also acknowledges the fact that different content lends itself to different methods of teaching. For example, the teaching of speaking skills for a foreign language teacher requires student-centered activities where students engage in meaningful and authentic communicative tasks. Contrast this to a graduate level art appreciation seminar where a teacher-centered lecture may be an appropriate way for the professor to describe and model ways of engaging with art. In this sense, PCK means going beyond being a content expert or just knowing general pedagogic guidelines, to understanding the unique interplay between content and pedagogy.

Technological Content Knowledge (TCK)

TCK describes knowledge of the reciprocal relationship between technology and content. Technology impacts what we know, and introduces new affordances as to how we can represent certain content in new ways that was not possible before. For example, today, students can learn about the relationship between geometric shapes and angles by touching and playing with these concepts on the screens of handheld, portable devices. Similarly, visual programming software now allows even primary school students to pick up programming by designing and creating digital games. In addition, technology enables the discovery of new content and representations of content; such as the relationship between the advent of Carbon-14 dating for archeology and the manner in which Google Trends can be used to predict the spread of the flu virus (Qualman, 2013).

Technological Pedagogical Knowledge (TPK)

TPK identifies the reciprocal relationship between technology and pedagogy. This knowledge makes it possible to understand what technology can do for certain pedagogic goals, and for teachers to select the most appropriate

tool based on its appropriateness for the specific pedagogical approach. Technology can also afford new methods and venues for teaching, and ease the way certain classroom activities are implemented. For example, collaborative writing can take place with Google Docs or Google Hangouts instead of face-to-face meetings, extending collaborative activities over distances. Also, the advent of online learning and more recently, massively open online courses (MOOCs) require teachers to develop new pedagogical approaches that are appropriate for the tools at hand.

Technological Pedagogical Content Knowledge (TPACK)

TPACK describes the synthesised knowledge of each of the bodies of knowledge described earlier, with a focus upon how technology can be uniquely crafted to meet pedagogical needs to teach certain content in specific contexts. Alone, each of the constituent bodies of knowledge that comprise TPACK represents a necessary and important aspect of teaching. *But effective teaching is much more than each of the pieces (TK, PK & CK).* For the teacher with TPACK, knowledge of technology, pedagogy, and content is synthesised and put to use for the design of learning experiences for students.

The TPACK framework is a testament to the complexity of teaching. The framework proposes that tackling all of the variables at once creates effective teaching with technology. The TPACK framework also functions as a theoretical and a conceptual lens for researchers and educators to measure pre-service and in-service teachers' readiness to teach effectively with technology. For this purpose, researchers have developed a range of instruments, quantitative and qualitative, to measure TPACK (Koehler, Shin & Mishra, 2011; Schmidt, et al., 2009).

Implications for Teachers

Because every teaching context is unique and there are varied interactions between technology, pedagogy, and content, there is not a universal or "one-size fits all" solution to the problem of teaching. Due to the intertwined relationships among technology, pedagogy and content, teachers face a great number of decisions. These decisions shift with permutations of technology, pedagogy, subject-matter and classroom context. The diversity of possible responses implies that a teacher should be an active agent and become *designers* of their own curriculum (Koehler & Mishra, 2005a). The complex and ill-structured nature of teaching with technology leads

to the idea of "teachers as designers" who are constantly engaged in the active, iterative, and feedback-driven process of problem-finding *and* creative problem-solving (Koehler & Mishra, 2005b). As Kafai (1996) suggests, in the design process,

> *… the designer begins by finding a problem, then discovers parts of the solution, tries to make sense out of it, considers how to reframe the situation, and continues with problem solving. This process seems to stop when an artifact has been created, but, actually, it never ends because existing design solutions are used and reused in new design situations. (Kafai,1996, p. 73).*

According to Brown and Campione (1996), curricula are comprised of pieces that act in cohesion, instead of a collection of teaching practices in isolation. Often, the failures in creating successful curricula that incorporate technology organically, stem from ignoring this idea of cohesion, and "trying to pull together disparate sets of items" (Mishra & Koehler, 2006, p. 1034). Therefore, the creator of such an intricate design piece can only be teachers who know, understand and craft the interrelated pieces into a meaningful whole. This is the essence of TPACK.

The constant process of negotiating among existing limitations causes designs to go through iterative cycles of change and refinement to create optimal learning experiences. This process is akin to bricolage (Turkle & Papert, 1992) that emphasises creativity and flexibility. Similarly, teachers often make creative decisions based on the teaching context, technologies available, how these tools can enhance the existing pedagogies that are determined based on the unique affordances and limitations of the content at hand. During the process of designing their own curricula, the decisions that go into making up the curriculum become the primary responsibility of teachers who understand the particularities of specific teaching contexts. For this reason, the design process helps teachers to become a part of the curriculum (Dewey, 1934).

The image of "teachers as designers" has also very important implications in informing teacher educators. Design, or learning by design, requires learners to actively experience the process, and they provide rich contexts for learning (Harel & Papert, 1990, 1991; Kafai, 1996; Perkins, 1986). In the next section, we describe approaches to teacher education in technology, and highlight the importance of learning by design.

Implications for Teacher Educators

Dozens of methods have been proposed for the development of TPACK, and they vary in their effectiveness. Among various approaches, an emphasis upon *how* teachers integrate technology in their practice is more important than the emphasis upon *what* teachers integrate in their practice (Mishra & Koehler, 2006).
For example, approaches that develop technological knowledge (TK) in isolation, where technology literacy is the goal, fail to assist teachers in the development of the educational uses of those tools. Similarly, approaches that develop only pedagogy or content – or even pedagogical content knowledge – do not capture the scope and unique flavor of knowledge needed to effectively teach with technology.

Other methods of developing TPACK have avoided these problems by focusing on different approaches to developing the connected, contextualised knowledge described in the TPACK framework. In the following sections, we describe two unique approaches: *learning technology by design* and by *activity types*. For other proposed methods of developing TPACK, interested readers can read Angeli and Valanides (2009); Brush and Saye (2009); and Niess, van Zee, and Gillow-Wiles (2010).

Naming their approach *Activity types* to reflect the kinds of domain-driven learning activities that teachers and students do everyday in their classrooms, Harris & Hoefer (2011) build knowledge about technology on to teachers' existing understanding. In this approach, teachers first formulate goals for student learning (Mishra & Koehler, 2009). Then, they choose activity types appropriate for the specified goals. Finally, they select specific technologies based upon their choice of activity types. Research indicates that activity types help teachers to make careful, strategic decisions around the integration of technology in their teaching (Harris & Hofer, 2011).

The *learning technology by design* approach emerged as a method for the development of TPACK through faculty and graduate students working together to develop online classes in a design-based seminar (Mishra & Koehler, 2005a). Through the act of *designing*, students and faculty constructed both online classes (that were later taught by the faculty) as well as an awareness of technology's role in reaching instructional goals for specific content. In this approach, students are not recipients of instruction, but undertake a "cognitive apprenticeship" with instructors (Mishra & Koehler, 2006). This design-based process is an authentic context

for learning about educational technology that recognises that design-based activities take on meaning and occur iteratively over time.

Principles of the learning technology by design approach (Mishra & Koehler, 2006) have been used to support design teams that have created educational movies, re-design existing websites, and developed curriculum used in K-12 schools. In the learning technology by design process, students design an educational technology artifact (e.g., an online course, movie, and redesigned website) that develops in-step with the student's progress through coursework or professional development. To accomplish this, students are organised into groups, and the initial discomfort students feel due to working in groups to solve ill-structured instructional problems is, over time, replaced with a sense of accomplishment and deeper engagement with course readings and discussions (Koehler & Mishra, 2005b). Throughout, the instructor employs the role of facilitator, available for immediate and ad hoc assistance to students as they progress towards the completion of their artifact.

All technology has affordances and strengths (Mishra & Koehler, 2006), regardless of the method teacher educators select to develop teachers' TPACK. Therefore, the development of TPACK should begin with relatively familiar technologies – with which teachers may have already developed TPACK – and to gradually progress to those that are more advanced (Koehler & Mishra, 2008; Koehler et al., 2011). In the case of pre-service teachers, whose knowledge development is limited not only with regard to TPACK, but also its constituent knowledge bases, such as PCK (Brush & Saye, 2009), it is important for teacher educators to first introduce relatively familiar technologies. Additionally and in order to facilitate the development of TPACK among preservice teachers, teacher educators should also identify and provide ample design opportunities to encounter authentic problems of practice slowly and in a spiral-like manner (Koehler & Mishra, 2008). The changing conditions and multiple contexts present challenges to the task of developing educators with TPACK. Nevertheless, a deep understanding of TPACK imparts the general, flexible knowledge needed to teach effectively with technology.

Conclusion

New technologies are driving necessary and inevitable change throughout the educational landscape. Effective technology use, however, is difficult,

because technology introduces a new set of variables to the already complicated task of lesson planning and teaching. The TPACK framework describes how effective teaching with technology is possible by pointing out the free and open interplay between technology, pedagogy, and content. Applying TPACK to the task of teaching with technology requires a context-bound understanding of technology, where technologies may be chosen and repurposed to fit the very specific pedagogical and content-related needs of diverse educational contexts (Kereluik, Mishra, & Koehler, 2010; Mishra & Koehler, 2009).

In confronting the ways in which technology, content, and pedagogy interact in classrooms contexts, we see an active role for teachers as designers of their own curriculum. Like all design tasks, teachers are faced with an open-ended and ill-structured problem in the process of crafting their curricula. This requires teacher educators to adopt, identify and select methods to develop technology integration knowledge by starting from already-existing bodies of teacher knowledge in a gradual manner (Koehler & Mishra, 2008); or in the case of pre-service teachers, to thoughtfully and slowly reveal authentic problems of practice (Brush & Saye, 2009). Technology education, therefore, should become an integral part of teacher education, moving beyond teaching technology literacy in isolation. Complexity is an everyday part of teaching, and the ubiquitous nature of digital technologies only adds to the complexity that teachers face. The TPACK framework, however, provides teachers with a tool to manage complexity. By recognizing the unique interplay between and among the core bodies of knowledge that comprise TPACK within unique contexts, TPACK provides teachers and teacher educators with a framework that guides them to achieve meaningful and authentic integration of technology into the classroom.

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CHAPTER - 3

Using UNESCO's ICT Competency Framework for Teachers in Guyana

Andrew Moore, Neil Butcher & Sarah Hoosen

Introduction

The Commonwealth of Learning (COL), the Commonwealth Secretariat (ComSec), and Microsoft recently supported the creation of an ICT Professional Development Strategy for Teachers in Guyana, building on the UNESCO ICT Competence Framework for Teachers[1] (CFT). The ICT CFT intends to inform educational policy makers, teacher educators, providers of professional learning and working teachers on the role of ICT in educational reform, as well as to assist countries in developing national ICT competency standards for teachers with an ICT in the Education Master Plan approach. In Guyana, the ICT Professional Development Strategy for Teachers is based on the assumption that if teacher training programmes embrace ICT, there will be improvements in learner performance. It acknowledges the central role that education officials, teacher trainers, educators, and learners play in the implementation and support of ICT in education.

The Guyana Context

Guyana, a sovereign state located on the northern coast of South America, has a predominantly rural population with only 28 per cent of its 780,000

[1] *www.unesco.org/new/en/unesco/themes/icts/teacher-education/unesco-ict-competency-framework-for-teachers*

inhabitants living in urban areas. Expenditure on education between 2005 and 2010 was 6.1 per cent of GDP (United Nations Statistics Division, 2013), that ranks the country 28th in the world (Central Intelligence Agency, 2013). However, functional literacy has been a cause for concern, and the government is thus actively addressing the quality of both primary and secondary education in Guyana. One of the challenges facing the education system in the country is the low retention of qualified teachers and subsequent employment of untrained and unqualified teachers. The Ministry of Education has therefore given priority to increasing the number of qualified teachers by providing opportunities to both pre- and in-service teachers to gain relevant qualifications. Additionally, using ICT in teacher education and training is at the forefront of efforts to tackle ineffective teaching and low-quality learning in classrooms. This is a challenge in a country where only 27 per cent of the population are Internet users (Central Intelligence Agency, 2013).

The Ministry of Education has thus developed an ICT Operational Plan, that recognises integrating ICT into education means tackling issues of content, access, and competency, as well as the actual integration of ICT into the processes of teaching and learning. This requires both teachers and learners to be competent users of the available technologies. However, there was a significant gap in the plan regarding teacher development in ICT integration. Therefore, the ICT Professional Development Strategy for Teachers was developed with the long-term outcome being to ensure that all Ministry of Education officials, teacher development management and staff, school principals, and teachers are competent to harness ICT effectively to support high-quality teaching and learning in Guyanese schools.

A New ICT Professional Development Strategy for Teachers: Stakeholder Focus

The ICT Professional Development Strategy for Teachers includes several initiatives required to implement it, and is essentially a comprehensive framework and learning pathway for managers, teacher educators, teachers, student teachers, and administrators to become competent in using ICT to support high-quality teaching and learning. This learning pathway uses the UNESCO ICT CFT as its guiding framework. It considers ways of incorporating ICT into the teaching of all subjects, requiring both student

teachers and in-service teachers across all disciplines to be trained in how best to exploit technology to teach their subject. One of the implications is that teacher trainers at the Cyril Potter College of Education (CPCE) and the Education Faculty at the University of Guyana (UG) would also need this set of knowledge and skills to support the training.

The strategy considers international trends as well as the local environment and ICT in education projects in Guyana. The typical school environment in this context is predominately rural, with limited access to computer infrastructure and Internet connectivity. The strategy therefore responds to these conditions, and considers a series of interventions resulting in a curriculum and set of teaching and learning materials that prepares new and in-service teachers to operate effectively in this environment. Consequently, the following components of the strategy were designed to achieve this end: curriculum review and improvement, development of teaching materials, testing, and deployment. Activities to support these strategy components also needed to be achieved in a relatively short period and with limited finances. The following outline describes how this was achieved.

Curriculum Review and Improvement

The Critical Role of the UNESCO ICT CFT

The UNESCO ICT CFT provides a framework around which a common core syllabus can be created. It can be used to develop learning materials sharable at a global level, provides a basic set of competencies that encourages teachers to integrate ICT into their teaching, and extends teachers' professional development so as to advance their skills in pedagogy, collaboration, and school innovation using ICT, and harmonizes different views and vocabulary regarding the uses of ICT in teacher education. The UNESCO ICT CFT emphasises the role that ICT can play in supporting six major education areas:

- ICT in education policy and vision;
- Curriculum and assessment issues;
- Pedagogy;
- ICT;
- School organisation and administration; and
- Teacher professional development.

It encourages an approach to teacher development that uses these areas to demonstrate directly the educational benefit that can be derived from ICT. Significantly, instead of presenting an ICT application approach, the framework provides a solid educational context for the development of ICT skills and competencies to integrate ICT into teaching and learning.

Another important component of the UNESCO ICT CFT is the cyclical nature of the competencies. The framework encourages teachers to acquire general ICT competencies, and then revisit the focus areas to develop them further. There are three approaches – Technology Literacy, Knowledge Deepening, and Knowledge Creation – each of which builds on the knowledge gained from the one before. As one progresses from one approach to another, the activities demand greater higher-order thinking skills.

As teachers complete the activities, they move from acquiring a basic understanding of issues relating to ICT to reinterpreting an educator's responsibilities in a way that will help them use ICT tools in various ways.

Mapping the ICT CFT Structure to the Guyana Teacher Training Environment

As highlighted, in the ICT Professional Development Strategy for Teachers, the learning pathway described for student teachers mirrors the UNESCO ICT CFT's cyclical path. In Guyana, diploma and in-service professional development courses are relevant to the Technology Literacy approach, bachelor-level courses are suitable for the Knowledge Deepening approach, whilst advanced specific short courses offered to experienced in-service teachers are in alignment with the Knowledge Creation approach.

The UNESCO ICT CFT is not prescriptive in how the teacher ICT competencies are achieved and while it does suggest approaches, course designers are free to develop courses that respond to local conditions to produce students who have the desired ICT competencies. It has not only provided a sound framework for teacher professional development but also freed Guyana courseware designers to exploit and adapt free high-quality Open Educational Resources (OER) rather than locking them into a costly proprietary environment or a product that could not be repurposed.

Guyana Materials Development Model

Given the capacity limits within the National Centre for Education Resource Development (NCERD), CPCE and UG, COL and ComSec contracted a consultant to develop draft teacher training materials. Part of the process involved creating a set of training modules for teachers to help them move through basic technology literacy to more advanced usage of technology. This was done in recognition that, if ICT is to become part of the way in which teachers teach, learners learn, and school managers operate, the teacher education curriculum (of both pre- and in-service teachers) should reflect the important roles that ICT might play in a typical school. Thus, at a series of meetings with the NCERD and staff of CPCE and UG, the consultants defined overall requirements for these modules. This can be summarised as follows:

1. A pre-assessment tool was required to assess whether participants had the basic ICT skills to participate in the first module. If not, students would be given a remedial training module to learn basic ICT skills (use of mouse, keyboard, etc.).
2. The Technology Literacy module was expected to last approximately 60 to 90 hours, comprising a blend of face-to-face interaction and self-study. It drew on the module designs already prepared by NCERD and CPCE, but also took into account the new course descriptions prepared for a revised teacher education programme in Guyana. Development of this module was based on the requirements of the UNESCO ICT CFT, and, to the greatest extent possible incorporated, existing materials to keep the course design cost-effective and globally relevant.
3. The Knowledge Deepening module, also based on the requirements of the UNESCO ICT CFT, would last approximately 90 hours and comprise a blend of face-to-face interaction and self-study.

The innovative curriculum and materials development process used in Guyana involved the following:

Mapping Guyana Curriculum to ICT Opportunities

The first step was to review the existing curriculum that involved examining the ICT in Education curriculum at CPCE and UG. The team recognised that the curriculum and associated materials should be designed to work

within the national context and mirror the conditions that teachers would find on the ground.

The consultants, with input from CPCE and UG representatives, then mapped the UNESCO ICT CFT and determined what treatment each competency identified by the framework would receive in practice. They proposed lessons or units around a framework competency, and addressed issues such as content, methodology, treatment, notional hours and support materials. This process allowed the writers to weigh the different focus areas and determine the number of hours a student should spend working on the materials. This detail shaped the development phases and was used to assess to what extent various draft versions satisfied the course's overall purpose and function. It also provided guidance for the next stage of development: determining which OER might support the lessons.

Selection of OER and Free Resources

Guided by the curriculum map, a four-person, part-time development team conducted an Internet search for potential resources relevant to the subject matter. In particular, OER was considered. Generally teacher education resources is well represented within the OER community but the development team found that few were created specifically with the UNESCO ICT CFT in mind.

In addition to identifying OER and free resources that were closely aligned to the course direction identified by the curriculum map, the developers also determined the quality and suitability of each resource found, as well as the amount of repurposing needed. Resources that required little repurposing were selected as far as possible.

Determining Use of OER and Free Resources

The development team also needed to assess how OER would be used to achieve the outcomes plotted in the curriculum map. This required a level of creativity and subject familiarisation. The development team therefore analysed the collected resources and removed those whose connection to the competencies described in the curriculum map were either tentative or which required too much repurposing to make them useful. The resources' specific copyright licence limited how and to what extent each resource could be used. For example, some resources had a licence prohibiting any repurposing. While the development principle was to limit repurposing as much as possible, there were nevertheless instances where the restrictions

on a resource made it unusable. In the few instances where a copyrighted work was deemed indispensable, copyright permission was secured to reproduce the work, and all copyright conditions were honoured.

Facilitation Guide Writing

The development team created a set of simple guides to map out the suggested learning pathway through the selected resources. In addition to identifying the sequence of learning events, the team also offered a set of suggested student activities so that the learning process was not merely didactic in nature but called on students to engage critically with the sourced OER. These activities were organised around four teaching and learning interventions: the lecture, the tutorial, the computer practical, and self-study sessions. The guides were constructed using a simple word-processing programme because they were only suggested routes and the developers appreciated that lecturers may wish to edit the documents to better suit their own teaching context.

These guides also contained facilitation notes on how best to organise tutorials and practical computer sessions, with each of the course's 36 units having its own guide. In addition, they assembled a list of further reading and references for the lecturers. Numerous hyperlinks to the various resources were embedded into the electronic version of the guide's pages.

Additionally, assessment opportunities formed a component of the guides. The assessment strategy included a grade book, mock papers, memos and portfolio assignments.

Deployment, Evaluation and Revisions

The content was piloted with stakeholders in Guyana to test the assumptions of the development team. Initial feedback from CPCE staff, as well as comments and suggestions from UG staff, were collected and collated to inform revisions to the course materials. A revision phase followed so that the collected user feedback informed changes to the course. This included, for example, less emphasis on the teacher facilitation notes so that they were aimed directly at the students rather than at the lecturing staff, and hence became teaching materials rather than guides. Additionally, the OER and free resources were downloaded on to a CD-ROM to eliminate the need for connectivity. An electronic version of the course was developed so that staff and students could choose between using the paper-based versions or the electronic CD-ROM. Further reading lists were also added to the

facilitation guides as they were considered useful for new staff/lecturers, student tutors and facilitators.

Exploiting the 'Release Early, Release Often' Model of Development

A quick and cheap development cycle was possible due to the available electronic materials, user-friendly digital tools and OER. However, because these tools and resources are constantly evolving and changing, they also demand repeated evaluation and updating. Consequently, the course development model in this project came to approximate what some open source software designers use for the development of software: "Release Early, Release Often" (RERO) (Wikipedia, 2013). The rationale is that only once the product is deployed and developers receive user feedback can it truly be customised to suit user needs, and that more reviewers or user feedback makes it easier to eliminate problems. Regular cycles of testing and revision align the product quickly and cost-effectively with user needs.

With course design, there are additional advantages to this approach. Besides responding rapidly to user feedback and creating a course aligned with student expectations, this model also enables designers to quickly improve the course as new OER or open courseware becomes available. The digital nature of the materials allows for quick and cost-effective changes to content. Course components can be replaced easily without affecting those components that are still required. Additionally, as new tools such as social networking, productivity or utility tools become available, these can be accommodated in the existing design with minimal disruption.

Furthermore, as class sizes grow, students are increasingly expected to be participants in conducting courses in ways that cannot be anticipated during the "development" phase as articulated by traditional models. Class participants can nominate digital tools that they prefer when working with their peers for reporting and discussing topics and issues. The digital nature of the tools, while not necessarily integrated directly into the course platform, can work in parallel. This model of course development allows for high levels of participant connectivity because it embraces a digital platform for course coordination, and also allows for frequent reflection and readjustment based on user feedback and developer evaluation.

Progress Made to Date

There has been significant success in developing modules aligned to the UNESCO ICT CFT and delivering them through CPCE, UG, and NCERD. Two complete professional development modules were developed (one on 'Technology Literacy' and one on 'Knowledge Deepening'). These were then re-versioned specifically for both pre-service and in-service teacher education, resulting in four modules.

In addition, initial professional development of selected staff in those institutions has been undertaken. For example, as part of the module development process, several workshops were conducted with staff from CPCE, UG, and NCERD to develop the skills of lecturing staff to deploy the modules. These professional development activities were well received by participants, and established a basis for subsequent delivery of the modules.

The modules have been successfully integrated into pre-service teacher education programmes at CPCE and UG, as part of the wider Guyana Improving Teacher Education Project (GITEP).

1. At CPCE, the modules were deployed in 2011 and 2012 to groups of around 200 students in each year. It is expected that the first module will be delivered to approximately 350 students in 2013. In addition, CPCE is offering a Foundational ICT Literacy module for students with no prior exposure to ICT, teaching them the basics of using ICT.
2. At UG, the modules have been implemented through Science and Technology subjects, and were delivered to approximately 125 students during 2012. Not all aspects of the modules have yet been implemented, as connectivity remains a problem, but the scope of delivery is expected to expand when connectivity is supplied. Encouragingly, approximately 25 students have also completed ICT Integration projects, demonstrating leadership as potential ICT champions within their schools.
3. At NCERD, the module on Technology Literacy has been delivered to in-service teachers during holiday workshops. These can only accommodate 75 students per session, so the modules have been delivered to 75 in-service teachers during 2011 and 2012.

As a result of the above activities, two resources have been created: a detailed

case study on the Guyana experience[2] and an ICT in Education Professional Development Toolkit.[3]

Lessons Learned During the Guyana Implementation

Many lessons were learned during implementation of the Guyana ICT Professional Development Strategy for Teachers and the materials development process. The most noteworthy lessons are highlighted below.

Understanding the Context

Despite current advances in e-learning that use ICT in increasingly sophisticated ways, the most appropriate use of ICT needs to be assessed in the context in which it will be used, in particular, taking consideration of infrastructural issues and human capacity. An ICT infrastructure is necessary if a professional development initiative like this one is to succeed. However, in this particular instance, the paper-based materials were regarded as possibly more useful than the electronic version because both access to ICT and familiarity with the tools are still limited for many students and teachers.

It is also important to consider the specific needs of a particular context, as engagement in the process and adoption of the course materials by the lecturers is enhanced, if the product meets a real need or requirement.

Importance of Leadership Support

High-level support of the initiatives is key for success while there is also merit in establishing a committee to bring key interests and stakeholders together for successful implementation. The Guyana Ministry of Education was farsighted in its realisation that at the core of this transformation was not the technology itself but rather the people who would be expected to use it. These people can be found at all levels within the education sector: the Ministry of Education, agencies, teacher training institutions and the schools themselves. Consequently, Guyana has built a professional development strategy that meets the needs of all its education stakeholders.

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[2] *http://www.col.org/resources/publications/Pages/detail.aspx?PID=409*
[3] *http://ccti.colfinder.org/toolkit/ict-toolkit/*

Importance of an Inclusive Design Process

Simultaneously, consulting as many stakeholders as possible was valuable particularly in the design process. For example, the process of consultation around the evaluation of the materials and course design with representatives from CPCE and UG was particularly beneficial. The consultants encouraged the process of using OER by promoting discussions around interpretations of 'open' in lesson design, and stakeholders were encouraged to present derivatives of the lessons presented on the CD in order to facilitate deeper understandings of OER and the UNESCO ICT CFT competency being developed within the lesson. The consultants regard such approaches as empowering stakeholders to understand how OER works and to undertake similar steps in their own course design. While the potential benefits of using OER are commonly known, it is especially encouraging that many in Guyana are now seeing the freedom granted by open licensing as a mechanism to provide tools that will transform education.

Whereas exposure to quality materials is considered significant, the exposure to different learning strategies has made a number of individuals who are responsible for shaping education in Guyana optimistic that OER might be the catalyst for a change in how we teach and how learners learn.

Creating Development Strategies from Existing Frameworks

The UNESCO ICT CFT provides an excellent point of reference for the creation or refinement of course development strategies. However, it cannot be assumed that teacher education providers have the necessary skills to develop, adapt and implement courses aligned with the UNESCO ICT CFT. Thus, some seed funding is likely to be needed to initiate activities to support technical assistance and capacity building to integrate the strategy into existing processes. Additionally, communication, advocacy, and a defined monitoring and evaluation strategy are important to support the process.

Cost Benefits of Adopting OER

OER can offer a cost-effective route to acquiring quality teaching and learning materials, especially in environments where resources are in short

supply. It is not, however, a shortcut to the normal materials development process. Time, skill, and creativity are required to rework the materials to satisfy a specific set of objectives identified by a curriculum committee or body. Nevertheless, a significant lesson learned during the Guyana Implementation is the cost benefit of adopting an open model. The overall cost of the development team is reflected in Table 1.

Table 1: Time and costs of developing the ICT Professional Development Strategy for Teachers in Guyana

Development team	**Time (days)**	**Costs (US$)**
Educational consultant/Instructional designer/Graphic and Web designer/Editor	32	16,624
Instructional designer 2	17	6,684
Instructional designer 3	19	7,290
Graphic and Web designer	7	1,453
TOTAL	**76**	**32,051**

As noted above, the Technology Literacy module lasts approximately 70 hours, whilst the Knowledge Deepening module lasts approximately 90 hours. It took 76 days (or 608 hours) to produce 160 hours of learning (of which 80 are effectively text- or print-based and 80 are computer-based instruction). Table 2 compares Swift's (1996; cited in Butcher & Roberts, 2004) estimates of time to design one notional student hour of learning with the actual time taken to develop the Guyana materials.

Table 2: Comparing Guyana design with Swift's notional estimates

Media	**Swift's notional estimate of time required to produce material equivalent to one notional learning hour**	**Actual hours taken to develop one notional learning hour of material**
Print	20–100 hours	3.8 hours
Computer-based instruction	200–300 hours	3.8 hours

However, as these are estimates for distance education course development and the Guyana courses are a blended learning design, it is possibly more

useful to compare the costs with the notional estimates from Bryan Chapman (in Clark, 2010). The result is no less startling (see Table 3).

Table 3: Comparing Guyana design with Chapman's notional estimates

Media	Chapman's notional estimate of time required to produce material equivalent to one notional learning hour	Actual hours taken to develop one notional learning hour of material
Instructor-led training (ILT), including design, lesson plans, handouts, PowerPoint slides, etc.	34 hours	3.8 hours
Standard e-Learning, including presentations, audio, videos, test questions, and 20% interactivity	22 hours	3.8 hours

These figures do not reveal an even greater cost saving, as the time reflected also includes the development of content-based on international examples (i.e., not Guyana specific and containing more generic content). Thus, the outcomes of the project were eight versions of content:

- Guyana Pre-service Information Literacy module (print version and CD version)
- Guyana In-service Information Literacy module (print version and CD version)
- Guyana Pre-service Knowledge Deepening module (print version and CD version)
- Guyana In-service Knowledge Deepening module (print version and CD version)
- International Pre-service Information Literacy module (print version and CD version)
- International In-service Information Literacy module (print version and CD version)

- International Pre-service Knowledge Deepening module (print version and CD version)
- International In-service Knowledge Deepening module (print version and CD version)

As all of this content is being shared under an open licence, the potential for achieving economies of scale grows further, as and where it is used by other institutions. Already, the material is being adapted for use in countries as diverse as Dominica and Indonesia, where it is being redeployed with marginal redevelopment time required to contextualise the materials effectively.

However, it is important to note that in this case, a key contributor to cost reduction was the leader of the team who was multi-skilled and thus able to serve several functions. The education consultant in this instance served multiple roles as an instructional designer, graphic and Web designer, workshop facilitator, and general editor. Traditionally, such functions have tended to be spread across multiple people, raising costs. This kind of multitasking has been facilitated by the growing access to content development tools provided by ICT, but also suggests that effective economic use of OER for course design and development requires highly skilled designers.

Conclusion

The Guyana ICT Professional Development Strategy for Teachers initiative has had many positive benefits. The creation of an ICT-friendly component for the teacher education curriculum in Guyana was achieved at a relatively low cost by using an existing curriculum framework (the UNESCO ICT CFT) and repurposing OER. Feedback from stakeholders indicated that the project went towards achieving the ICT vision articulated by the government in encouraging the next generation of teachers to improve ICT competencies by using ICT for educational purposes. It also encouraged teachers to adopt new teaching strategies, and has opened opportunities to consider the important role of adapting OER to promote learner centric learning in the future.

The initiatives designed to build educators' capacity illustrate that digital

resources such as the UNESCO ICT CFT and OER, as well as many of the ICT tools available, add value rather than simply adding to existing responsibilities. After an initial investment of time and resources, ICT will lead to improved productivity, enhanced teaching and learning, and more effective administration and communication channels. The Guyana ICT Professional Development Strategy for Teachers illustrates a potential pathway to achieving a transformation.

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CHAPTER - 4

Technology, Education and Design: The Sciences of the Artificial

Som Naidu

Introduction

In his classic book *The Sciences of the Artificial*, Herbert Simon differentiates between the natural sciences and the sciences of the artificial. He proposes that fields of scholarship such as *technology*, *education* and *design* comprise the sciences of the artificial, just as chemistry, physics and biology are regarded as sciences of the natural phenomena. The natural sciences (including social sciences) are areas of study that are concerned with defining the nature of things. They help to explain the world around us and things as they are (Simon, 1969, 132–133). The sciences of the artificial, on the other hand, include areas such as computing, engineering, architecture, and education and these disciplines are concerned with defining how things ought to be. A defining characteristic of the sciences of the artificial is *design*. This chapter explores the fields of *technology*, *education* and *design* (as sciences of the artificial) and discusses their separate as well as combined implications for the *design of learning and teaching experiences*.

Technology

Traditionally, conceptions of technology, especially in the educational arena conjure references to information and communications technology specifically those that are electronic in nature, such as computers, and communications devices including telephones, radio and televisions. A quick search of the Web however reveals that technology means a lot more than just hardware and software accompaniments. The business dictionary defines technology as…

the purposeful application of information in the design, production, and utilization of goods and services, and in the organization of human activities. Technology is generally divided into five categories:

1) *Tangible*: blueprints, models, operating manuals, prototypes;
2) *Intangible*: consultancy, problem-solving, and training methods;
3) *High*: entirely or almost entirely automated and intelligent technology that manipulates ever finer matter and ever powerful forces;
4) *Intermediate*: semi-automated partially intelligent technology that manipulates refined matter and medium level forces;
5) *Low*: labor-intensive technology that manipulates only coarse or gross matter and weaker forces.

(Retrieved from: *http://www.businessdictionary.com/definition/technology.html)*

Notice the reference in this definition to words such as "blueprints, models, and operating manuals" as well as "consultancy, problem solving, and training methods". None of these would need to be a machinery of any kind. They refer to techniques and processes. Similarly, according to Wikipedia…

The word technology refers to the making, modification, usage, and knowledge of tools, machines, *techniques*, crafts, *systems, and methods of organization*, in order to solve a problem, improve a pre-existing solution to a problem, achieve a goal, handle an applied input/output relation or perform a specific function. It can also refer to the collection of such tools, including machinery, modifications, arrangements and procedures...

(Retrieved from: *http://en.wikipedia.org/wiki/Technology)*

Notice in this definition of technology as well, reference to "systems, and methods of organization" and "arrangements and procedures". The point really is that technology is a lot more than machinery and hardware, and that much of it comes in the form of software. These can be in the form of *plans, processes, techniques and strategies*. Or, as Mike Spector puts it "technology involves the practical application of knowledge for a purpose" (see Spector, 2012; 5).

Education

The Wikipedia defines…

> Education in its general sense [as] a form of learning in which knowledge, skills, and habits of a group of people are transferred from one generation to the next through teaching, training, research, or simply through auto-didacticism. Generally, it occurs through any experience that has a formative effect on the way one thinks, feels, or acts.
>
> (Retrieved from: *http://en.wikipedia.org/wiki/Education)*

Education as a field of practice comprises the acts of teaching and learning. Learning has much to do with memory and cognition, and teaching has a lot to do with the design of the learning experiences so that desirable learning can take place. Neither one is sufficient on its own. Learning and teaching go hand in hand, and they are parts of the same educational transaction (see Spector, 2002).

"Education, like technology involves change in addition for being purposeful and specific to a subject matter domain" (see Spector, 2002; p. 7). It is true that learners can learn by themselves such as in the case of independent study (through self-study or auto-didacticism). But even in this case there is teaching going on. Some of this is designed in the learning resources one chooses to use, and some of it is provided by the learners themselves in the form of strategies they choose to use (such as note taking, concept mapping, summarising and rehearsing) as part of their learning activities.

Learning is not learning if a formative shift in one's cognitive schema has not occurred. And teaching is not teaching if one has not learned. As Noel Pearson (an Australian Aboriginal Activist) bluntly put it, "if the student has not learned, the teacher has not taught" (2009, p. 35). But teaching is not simply about talking to students about a body of subject matter knowledge. If learners have not learned anything, then all a teacher may have done is 'talked' to them, or given them a "lecture".

Teaching is a lot more than that. It is about influencing one's cognitive schema with new knowledge and realisations and/or new approaches to

viewing reality. It is about moving minds (see Laurillard, 2012). Teaching is about motivating students to want to learn (see Keller, 2008; Mathews, 2009). It is about placing "students in an environment where they want to learn and where they can naturally discover their true passions" (see Robinson, & Aronica, 2009, p. 238), and "great teachers have always understood that their real role is not to teach subjects but to teach students" (p. 249).

Design

Design is concerned with applying knowledge and intuition to come up with artefacts that have not been invented or applied yet. The act of designing begins with an in-depth knowledge of core principles as well as a very thorough understanding of the context. Quite often a particular design is the outcome of the interactions between the design act and the issues and requirements of the context. Seen in this manner, design is a "situated act" (see Suwa, Gero, & Purcell, 2000, p. 235).

At the heart of learning and teaching is design. Effective, efficient and engaging learning and teaching are the result of good *learning experience design* that is a creative process. In the case of education generally, and learning and teaching more specifically, the principles for designing will have been derived from extensive study and investigation into human learning and cognition, the affordances of technology, knowledge of the learning and teaching context as well as best practices in teaching. Classic examples of notable learning experience designs are *problem-based learning* (Barrows, & Tamblyn, 1980), *scenario-based learning* (Clark, 2012; Naidu, Menon, Gunawardena, Lekamge, & Karunanayaka, 2007), and *case-based reasoning* (Kolodner, 1993).

Unlike the natural sciences, education generally, and teaching in particular, is best seen as a *design science* which has the aim of continuous quality improvement based on best practices (see Laurillard, 2012, p. 8). Education that includes learning and teaching are multivariate and complex processes. And unlike the natural sciences, investigations into most aspects of education, learning and teaching are not well suited for experimentation. Research and scholarship in learning and teaching are best achieved through critical reflection on practice. But this does not mean that experimental and/or quasi-experimental methods are unsuitable for the investigation of

particular aspects of learning and teaching, and it certainly does not mean that investigations into learning and teaching can be any less rigorous than that which is acceptable in the natural sciences.

It suggests that investigations into aspects of learning and teaching are best accomplished with a range of strategies through naturalistic inquiry from the qualitative paradigm. Widely used, such a strategy is *design research* or *design-based research* (see Design-Based Research Collective, 2003; Nelson, 2013). Simply put, design-based research is about developing a design, building a model of the process based on that design, implementing it, and then collecting data on its performance, strengths and weaknesses using a wide range of data gathering techniques.

A classic example of this would be developing and implementing a programme of curriculum reform or course design in a particular educational context. It would be meaningless to compare such an approach or model with another. Even if it were the same model with the same theoretical orientation, the context would be different. Comparisons of their efficiency and effectiveness would not be very meaningful. An ethnographic approach would be better suited to evaluating the impacts of such a process or programme. And evaluations, as a form of research, if they are rigorously conducted, can be very insightful and illuminating (see Patton, 2008).
In this manner, much of educational practice is design-based, and lends itself to design-based research. It incorporates building programmes and implementing processes that are based on tried and tested principles and practices, and evaluating their impacts on stakeholders, systems and organisations based on a rich variety of perspectives, and with no less rigour than experimental methods (see Anderson, & Shattuck, 2012).

Implications for learning experience design

Learning and teaching are core components of most forms of educational practice. And like any form of educational practice, they are design-based activities. From self-study, to a didactic lecture, to group-based problem-based learning and role play, some level of design is integral to any form of learning and teaching activity. In the case of a lecture, for instance, along with defining the focus and scope of the lecture, a teacher needs to research and compile the subject matter content in a meaningful way. And also consider issues such as sequence and timing of the lecture, the audience

and the ambience of the venue in order to ensure achievement of the goals of the lecture and ensure maximum impact.

The level of design increases in scope and intensity as the learning and teaching activity becomes more complex. A number of factors become relevant when this is the case. These include decisions that need to be made around the *scoping and selection of the subject matter content that needs to be taught*, its *delivery mode and technologies* that will be used, and the *pedagogical principles* that would drive the design of the learning and teaching experience including methods and strategies for the assessment of learning achievement and how feedback will be provided.

Decision-making around all of these variables requires specialist knowledge about *technology*, *pedagogy* and the *subject matter content*. This is knowledge about the affordances of technology as well as the pedagogy for different kinds of subject matter content (Kennedy, 2015). Popularised as *technological pedagogical content knowledge* (TPCK) by Mishra and Koehler (2006), this is a concept that has its origins in Shulman's (1986) notion of *pedagogical content knowledge* (PCK) and it comprises knowledge that lies at the intersections of these three variables. Figure 1 seeks to capture these knowledge domains. These domains and their implications for the design of the students' learning experience are discussed in the remainder of this chapter.

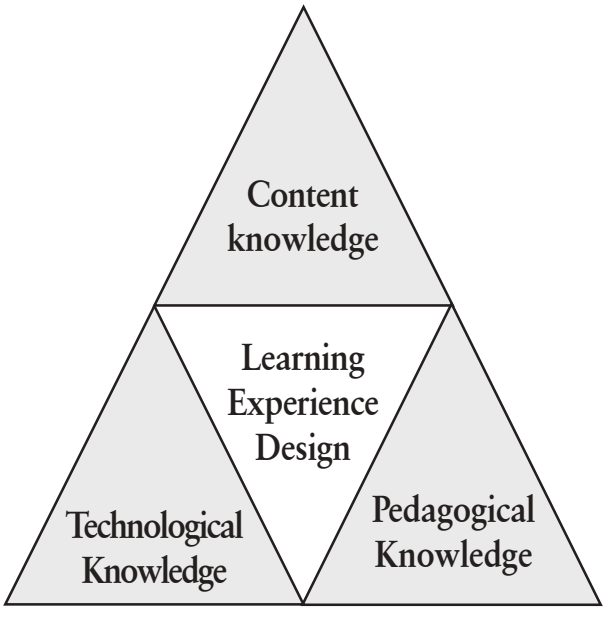

Figure 1. *Implications for learning experience design*

Technological knowledge

This is knowledge about delivery modes and the tools and technologies that are used in any educational delivery mode. Take for instance the contemporary lecture hall in face-to-face educational settings. In the more developed educational contexts, this is no longer just a room full of desks and chairs and a blackboard or whiteboard at the front of the room. The contemporary lecture hall might have mobile furniture and a suite of technologies to control sound and lighting in the room, and tools for the recording of a lecture and other deliberations in the room. It might also have facilities for twitter feeds in real time, and possibilities for various other forms of communication between and among students as well as students and the teacher. Without a solid grasp of how to operate these tools, troubleshoot and manage the deliberations there in this environment, a lot could go wrong with a straightforward lecture.

The distance education and the online learning and teaching environment offer far greater challenges and levels of complexity. Contemporary distance education systems and online learning environments comprise the use of many more sophisticated tools and technologies from various forms of synchronous and asynchronous communication channels including multipoint audio and video conferencing, online learning management systems including synchronous and asynchronous discussion tools, and a range of widely accessible social media tools. Contemporary learners not only have easy access to these tools and technologies but are very comfortable with using them frequently. Knowledge of how to use these technologies, troubleshoot them and help students use them effectively in their learning is essential competency for any teacher (see Baggaley, 2012).

Decisions around their use have to do with choices about delivery modes and the mix and match of individual technologies in any mode. In fact the term "delivery" is inappropriate here as, except for perhaps the lecture format, teaching is no longer about "delivering" anything to anyone in complex educational settings. In such settings, the term delivery becomes an inadequate descriptor of what teaching is really about. Here *teaching is fundamentally about the design of student learning experiences*. The choice of mode in this case will have to do with how much of it is going to be one-on-one or group-based, and face-to-face, online, at a distance or in a combination of these modes.

Decisions around these issues will need to be aligned with organisational

orientation and its educational philosophy. Organisations that purport to be distance education organisations, for instance, will very likely have the balance tipped in favour of more distance education provision, whereas conventional campus-based organisations will tip the balance in favour of more face-to-face educational offerings including the blending of various modes (see Baggaley, 2012; Naidu, 2010a).

How different modes might be used to "blend" one's approach will also depend on the purported organisational orientation, as well as a host of other factors including the level of study, the nature of the subject matter or skill that is being communicated, and the duration of the study. It might be possible, for instance in higher levels of study such as at the doctoral level, to have more of it carried out as private study and away from the campus, while first year undergraduate study in medicine and the engineering sciences requiring greater residential and perhaps one-on-one or small group-based and face-to-face contact because of their practical and hands-on components, will require more of it to be conducted in single and in group-based laboratory or practice-based settings.

The choice of individual technologies will also vary depending upon the existing infrastructure in an educational context, learners' and teachers' access to online and digital technologies as well as its purpose. For instance, despite the existence of infrastructure to support online and digital communications in an educational context, print may still be the ideal means for the communication of large amounts of reading material. And this may be so because of the portability of print and the flexibility it affords the learners in any context, developed or developing (see Naidu, 2010a).

Pedagogical knowledge

This comprises a deep level of understanding of principles about learning, teaching and cognition, how they work in different situations for different kinds of learners and with different kinds of subject matter. A partial or limited understanding of these principles would be insufficient, as it is one's understanding of these principles and how they interact that will drive the design of their approach to teaching as well as the design of their students' learning experience.

This will include developing strong belief systems about learning, teaching

and cognition that can be backed up with evidence from extant literature and practical experience. These belief systems could revolve around what one might think about particular approaches to cognition as well as the affordances of various technologies. For instance, how much structure and guidance and how much interaction or flexibility is going to be enough, with which group of learners, in which kinds of educational contexts, and with what kind of subject matter content or skill.

It is not possible to start to think about any form of teaching activity without having some view about factors to do with learning and cognition, no matter how transient. These factors include how a particular group of learners might like to approach their learning activities (see Kember, 2001), their pervasive learning styles (see Richardson, 2005), the nature of the subject matter content, and the time that might be available, both for teaching and for learning purposes.

There is a great deal of literature that sheds light on all of these factors (see Laurillard, 2012). Even the straightforward didactic lecture is probably influenced by one's belief that certain concepts have to be explained by subject matter experts, and students might actually expect that someone will explain it to them, especially if they are reading or hearing about something for the first time (Chen, Bennett, & Maton, 2008; see also http://www.facultyfocus.com/articles/teaching-professor-blog/didnt-teach-learn/).

Different kinds of subject matter will require different kinds of approaches. And these approaches will be driven by different belief systems about learning and cognition. The development of higher order thinking, for instance, and the development of graduate attributes such as problem solving, critical thinking, interpersonal and group-based communications skills, collaborative working and team-building will require a different kind of approach to the lecture. These approaches will need to be scenario-based and problem-oriented. They will need to be learner and learning centered, not teacher or content-centered. And they will need to promote the idea of learning by doing, as opposed to learning by listening or watching (see Barrows, & Tamblyn, 1980; Naidu, 2004; 2008; 2010b; Schank, 1997). How learning achievement will be assessed and feedback provided are critical components of an understanding of pedagogical content knowledge (see Naidu, 2004). This will need to be aligned with the pedagogical model and the principles underpinning the approach to teaching, and its expected

learning outcomes. If the learning outcomes are of a lower order such as remembering and recalling, then assessment of such learning outcomes might take the form of a closed book examination.

However, if the learning outcomes were of a higher order, such as the abilities to synthesise, evaluate and create, then the methods of assessment of such learning outcomes will have to be approached through a wide range of activities and outputs including artefacts such as project reports, reflective journals and portfolios, all of which are far better suited to ascertaining more than the understanding the subject matter content.

Subject matter knowledge

This is knowledge about the subject matter that is to be learned and taught. It comprises a thorough knowledge of the *facts, principles* and *procedures* of the body of the subject matter that learners will need to understand and be able to apply to different situations and contexts. Inadequate grasp of the subject matter, or not knowing where to source it, and how to communicate it to novice learners, pose some of the greatest challenges to teachers.

Decisions around the subject matter content will have to do with scope and coverage, its sequencing and synthesising for different levels and kinds of learners, and using different kinds of technologies in different educational contexts. Among the many theories and propositions for optimum ways of sequencing and synthesising subject matter content are those that have been articulated by David Merrill (see Merrill, 2002; Merrill, 2013), and Charles Reigeluth (see Reigeluth, 1992).

The five principles that underpin Merrill's proposals for sequencing and synthesising instruction and their implications for learning and teaching are as follows (see also Merrill, 2002; Merrill, 2013):

1. *Demonstration:* Proposes that learning is promoted when learners are observing a demonstration.
2. *Application:* Proposes that learning is promoted when learners are applying the new knowledge.
3. *Task:* Proposes that learning is promoted when learners engage in a task-centred instructional strategy.

4. *Activation:* Proposes that learning is promoted when learners are activating relevant prior knowledge or experience in order to complete assigned learning tasks.
5. *Integration:* Proposes that learning is promoted when learners are integrating their new knowledge into their everyday life.

At the heart of Reigeluth's proposals and suggestions for sequencing and synthesising instruction is the notion of "elaboration" that builds upon David Ausubel's work on the role of advance organisers in learning and teaching (see Ausubel, 2000), and Jerome Bruner's concept of the spiral curriculum (see Bruner, 1960). Reigeluth's elaboration theory suggests that teaching is most effective and efficient when it is organised in an increasing order of complexity where the simplest tasks and activities are introduced first and these are then followed up with increasingly more complex and complicated tasks and activities. In these conditions and at all times, learners are building upon what has already been learned.
Reigeluth's elaboration theory comprises the following main steps:

1. *An elaborative sequence* that proposes a simple to complex ordering of concepts;
2. *Learning prerequisite sequences* that suggest the introduction of concepts in an order of increasing complexity;
3. *Summarising and synthesising* that recommend that there is built into this sequence, opportunities for summarising content already covered;
4. *Use of analogies and other cognitive strategies* that has the potential to provide structures for subsequent learning activities; and
5. *Providing opportunities for learner control* that will enable learners to customize learning that is best suited to their learning styles and approaches.

The first piece of instructional activity in this sequence is most critical as it seeks to *epitomise* and not just merely *summarise* the content that will follow. The proposition of elaboration theory is that this kind of sequencing of subject matter content has the greatest potential for developing stable cognitive structures for the development and retention of increasing levels of complexity in the subject matter knowledge.

Merrill's first principle of instruction and Reigeluth's elaboration theory are two of the most prominent perspectives on sequencing and synthesising

instructional content. While the principles they articulate are generic and applicable in any educational setting, the technology used for mediation in the learning and teaching processes they articulate would vary for different kinds of learners, subject matter and educational context. In distance education and online educational settings, for instance, how the content is presented and mediated would differ from the way it might be dealt with in a face-to-face class (see Naidu, 2010a). This is never a constant phenomenon, as the tools and technologies available to teachers are, and will continue to be changing, both in the conventional classroom, and in the distance education and online world. In this regard, teachers will always have to be up skilling themselves in order to be effective and efficient, and making the most of the affordances of contemporary tools and technologies regardless of their educational context.

Concluding remarks

Great teaching is about designing a potent learning experience for the students where their learning is most *effective, efficient, engaging and enjoyable*. This kind of teaching requires careful thought to what will be taught and learned (i.e., the subject matter), how it will be taught and learned (i.e., its pedagogical approach), and what tools and technologies (i.e., technology) will be used by the teachers and students, as well as how much time will be spent on teaching and learning (see Kennedy, 2015). *Simply put, great teaching is when students can claim to have learned something.*

And as I have suggested throughout this chapter, this requires an in-depth understanding of not only the subject matter, but the pedagogy (i.e., the art and science of learning and teaching), and the technology, as well as knowledge that lies at the intersections of these variables. This is what Mishra and Koehler (2006) have called *technological pedagogical content knowledge* (TPCK). Seen in this manner, *teaching is a design science* that requires careful thought and expertise not unlike that which is required for the design of roads, bridges and buildings or, for that matter, any such infrastructure or artefact. And teachers are *architects* and *choreographers* of this learning experience like directors of ensembles, or architects and engineers of roads, bridges and buildings.

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CHAPTER - 5

Teleconference Based model of Capacity Building for ICT Integration

Saroj Pandey

Introduction

Teaching is a creative and individualistic process that requires rejuvenation of teachers' knowledge and competencies on a continuous basis as the impact of pre-service education cannot be sustained over a period of time due to the fast pace of changes in the knowledge and information sector and consequent demands on teachers. Teachers like other professionals are expected to continuously update their knowledge and pedagogical skills to contribute meaningfully in the development of human resources of the country. India has a large number of teachers employed in the education sector who need continuous orientation and up gradation of their skills and competencies. According to the 8th All India Educational Survey (2009) 6,051,639 teachers are employed in the school education sector of the country that requires recurrent professional development. Equally, large numbers of teaching professionals are working at the higher education sector. Addressing the continuous professional development needs of such a large population means that institutions responsible for their in-service education are well equipped with adequate infrastructural facilities and human resources to address the needs. However, experiences in the area of in-service teacher education in the country reveal the inadequacy of both these resources to meet the policy mandate of professional development of teachers once in five years. If we take into account the number of the existing teacher education institutions mandated to provide in-service

training to teachers in comparison with the number of teachers in need of such training programmes, through the traditional face-to-face training programmes, the enormity of problem and difficulty of meeting the NPE (1986) mandate of providing in-service training to teachers once in five years can be understood. Limited number of 571 DIETs, 31 IASEs, 109 CTEs and 37 SCERTs cannot cope with the burden of providing in-service training to more than 7 lakh teachers employed in the school education sector. Similar concern has been expressed by Pandey (1999). Even if the in-service training programmes are organised in a mass level, such as, in the case of centrally sponsored schemes of the Programme of Mass orientation of School Teachers (PMOST), and Special Orientation of Primary Teachers (SOPT), it takes years to achieve the target population. In addition, the face-to-face model of in-service education of teachers (INSET) generally follows the multilayered cascade model of training that affects the quality of training from one layer of hierarchy to another due to transmission loss. Further, India faces the challenge of providing recurrent training to a large number of teachers scattered in rural and remote areas where it is difficult to reach. There are also problems such as shortage of science and mathematics teachers, and those in the system lacking the necessary competencies and skills. We also have huge number of teacher educators and other functionaries employed in the education sector requiring recurrent training. It is extremely difficult to meet the in-service requirements of all these groups through the existing institutional network in the traditional face-to-face mode.

Considering the limitation of the tradition model of teacher training and its trickle-down effect for professional development of teachers (it may take years to cover the target groups), technology based models provide effective alternative options and have the capacity to overcome the limitations of the traditional model of teacher training. The advent of Information and Communication Technology (ICT) in education has resulted in proliferation of a number of technology-based models of education and training. Teleconferencing is one such model that promises an effective means for providing equal quality of training to a large number of teachers together. It is also possible to utilise state-of-art ICT facility in an interactive mode. It can be facilitated by immediate interaction through two-way communication between the teaching and the receiving ends as well as through fax, STD, emails, etc.

Teleconferencing based model for capacity building of teachers

Distance education has established its relevance and efficiency across the globe and is considered as having immense potential for continuous professional development of teachers. By infusing various technologies in the teacher training process, teachers' professional learning can truly be made a career long process. There are numerous instances of ICT being used as an intervention strategy in professional development enabling teachers to take responsibility for their own learning. Use of ICT for professional development of teachers provides the flexibility necessary for successful delivery of education. Delors report (1996) and UNESCO World Education Report, *Teachers and Teaching in a Changing World (UNESCO,1998)* recognised the potentials of distance education technology for in-service education of teachers and considered it as a more economical and effective means of implementing reforms or introducing new technologies or methods. The technology based models are being widely used by both developed and developing countries for in-service teacher education programme. Indonesia, Brazil, Pakistan, Latin America, USA, Australia, UK, Nepal, Sri Lanka, Bangladesh and China, etc. have been using distance technology successfully.

The UNESCO report entitled *Information and Communication Technologies in Teacher Education: A Planning Guide* (2002) identifies the importance of ICT for teacher education as "teacher education institutions may either assume the leadership role in the transformation of education or be left behind in the swirl of rapid technological changes. For education to reap the full benefits of ICTs in learning, it is essential that pre-service and in-service teachers have basic ICT skills and competencies."(p.13). Needless to say that there is growing pressure on teacher education institutions to prepare teachers who are confident and competent in using ICT in their personal and professional lives; that is 'students should learn about, learn with, and learn to incorporate technology into their own teaching, (SITE, 2002).

The importance of ICT for education and teacher education has also been recognised and well-articulated in all the national policies and programmes initiated in the country. The National Curriculum Framework for School Education, 2005 and subsequently, the teacher education curriculum frameworks of 1998 and 2009 articulated the need of integrating ICT in teacher education programmes, both at pre-service and in-service stages.

The National Focus Group on Educational Technology (2006) suggested that the pre-service teacher education programmes should incorporate the '*use of media and technology enabled methods of learning, making them inherent and embedded in the teaching learning process.*'(p.15). It further suggested ICT literacy for not only teachers but also for educational leaders, headmasters and principals, etc.

The report of the National Knowledge Commission (2008) has given significant importance to ICT in education and recommended that 'wherever feasible ICT should be made more accessible to teachers, students, and administration of learning, training, research, administration, management, monitoring, etc. This requires the provision of more facilities such as computers as well as connectivity and broadband facilities. Computer-based learning also requires training of teachers and other staff in order to make the best use of technology.'(p. 24). Expressing its concern over the quality of both pre-service and in-service teacher training programmes, the Commission expressed the need to improve the quality of both levels of teacher training programmes by adopting greater flexibility in teacher training modalities and incorporating ICT fully in teacher training programmes, that in turn will lead to more frequent use of ICT in classrooms. Therefore, 'ICT should be made more accessible to teachers, students, and administrators for learning, training, research, administration, management and administration etc. This requires the provision of more facilities such as computers and broadband facilities. Computer aided learning also requires training of teachers and other staff in order to make best use of technology' (p. 42). It has further recommended establishment of a web based portal for teachers to exchange ideas, information and experiences. Verma Committee report (2012) has also visualised a greater role for distance education techniques in the continuous professional development of teachers.

The Information and Communication Technology (ICT) and its use for the purpose of education and training have undergone significant change from the launch of the first multipurpose geo-stationary satellite INSAT 2A (1992) utilising the Transportable Remote Area Communication Terminal (TRACT) to EDUSAT (2004) with state-of-art technology. With the success of INSAT based educational services a need was strongly felt to launch a satellite dedicated to educational service. Subsequently, ISRO launched the first satellite dedicated exclusively to education, known as EDUSAT in September 2004. This satellite has multiple regional beams

covering different parts of the country – five Ku-band transponders with spot beams covering northern, north-eastern, eastern, southern and western regions of the country, a Ku-band transponder with its footprint covering the Indian mainland region, and six C band transponders with their footprints covering the entire country. ISRO provides two types of EDUSAT Terminals namely: Satellite Interactive Terminals (SIT) and Receive Only Terminals (ROT). While SIT provides for interaction in real time with remote teachers, the ROT, a television based system, can only receive programmes transmitted through EDUSAT. This network is operational in 24 states of the country including the islands (Andaman and Nicobar, Lakshadweep), Jammu and Kashmir and the north-eastern states (Indian Space Research Organisation, 2014). It has successfully met the demand of interactive satellite-based distance education for the country and Kerala became the first state to launch virtual classes through EDUSAT at the elementary level. Other states also followed soon and today EDUSAT is being extensively used for education and training of students, teachers, teacher educators and other professionals also.

Use of Teleconferencing for Special Orientation of Primary Teachers (SOPT) by National Council of Educational Research and Training (NCERT)

The National Council of Educational Research and Training (NCERT) made a pioneering effort to utilise teleconferencing for use of ICT in capacity building of teachers. The NCERT in 1993–94 significantly integrated multimedia technologies in two major centrally sponsored in-service teacher training programmes: Primary Mass Orientation of School Teachers (PMOST) and Special Orientation of School Teachers (SOPT).

The experiment first began in 1996 through one-way video and two-way audio teleconferencing programmes for training of primary teachers under the Centrally Sponsored Scheme of in-service training of primary teachers known as 'Special Orientation Programme for Primary Teachers' (SOPT). It has been further extended by NCERT to two-ways audio and two-way video teleconference programme with the onset of 21st century. After the implementation of the National Curriculum Framework (2005) for School Education, NCERT has extensively used the video-conferencing facilities

to orient teachers working at various stages of school education on NCF2005.

The one-way video and two-way audio programmes of NCERT for training of primary teachers called as 'Tele SOPT' was initiated on experimental basis in 1996. Two such training programmes, having seven days duration each were organised for primary teachers of the states of Karnataka and Madhya Pradesh in 1996 and 1997, respectively. In 'Tele SOPT' Karnataka, 850 teachers assembled at 20 identified training centres in the state and were provided training. The programme organised for primary teachers of Madhya Pradesh covered a much larger number of 1400 primary teachers through 45 learning centres of Madhya Pradesh. Similarly, 700 primary teachers of Karnataka (1997) were provided training in teaching of mathematics through 20 identified learning centres in the state, by NCERT through its 'Tele Maths' programme. All these programmes had been quite successful and the teleconferencing programme was further extended to the in-service training of teacher educators of the District Institute of Education and Training (DIETs) of Madhya Pradesh. The evaluation of these programmes (Phalachandra (1997), Pandey (1999), Putela (1998), etc.) reveal the success of teleconferencing as a means for capacity building of a large number of teachers simultaneously ensuring equal quality of training to thousands of teachers through a single programme that is not possible with the conventional cascade model of training that suffers from serious quality concerns in terms of training inputs provided by different resource persons at different levels of training. Teleconferencing provides opportunity to a teacher sitting in the extreme corner of the country to watch and interact with resource persons.

Teleconferencing for capacity building of Teachers under DPEP and SSA

Another significant attempt has been made in the use teleconferencing for training to teachers under the District Primary Education Programme (DPEP), a comprehensive national programme aimed at attaining Universalisation of Elementary Education (UEE) through the District Primary Education Project–Distance Education Programme (DPEP-DEP) located at Indira Gandhi National Open University (IGNOU). Utilising a thoughtful combination of teleconferencing with media and face-to-face components, this programme successfully reached out to more than 23000

primary teachers, teacher educators and other functionaries associated with primary education in 18 states of the country. A total of 112 teleconferencing programmes were organised at the national and state levels (DEP-DPEP, 2003). It is pertinent to note that teleconferencing has frequently been used under the DEP-DPEP programme by IGNOU, as well as various states to provide training to teachers, and coordinators of Block Resource Centres (BRCs) and Cluster Resource Centres (CRCs) during the entire period of the operation of DPEP programme.

Later on, the Government of India launched its flagship Scheme the Sarva Shiksha Abhiyan (SSA) for Universalization of Elementary Education in the mission mode in 2001, merging various schemes of UEE including the DPEP. One of the focus areas of SSA has been capacity development of teachers at district, state and national levels as a means to address the quality concerns at the elementary level. The Distance Education Programme (DEP) had been accepted as the national component within Sarva Shiksha Abhiyan (SSA) by MHRD, Government of India in collaboration with IGNOU as the nodal institution in 2003 in all the 35 states and Union Territories of the country. The main objective of DEP-SSA has been to evolve a sustainable training system for elementary school teachers and functionaries through open and distance education inputs, like developing high quality training materials (print, audio video, multimedia packages) workplace-based training inputs and training in content generation for ICT inputs (Jena et al., 2009). The DEP-SSA, IGNOU has used teleconferencing programmes in large scales for providing cost effective training to various functionaries under SSA in addition to the elementary teachers during the period of its operation from 2003 to 2013. Therefore, teachers across the country had the opportunity to interact with national level resource persons directly through the teleconferencing and get equality quality of training. Thus DEP-SSA has empowered teachers and other functionaries for effective transaction of curriculum at the elementary level.

The SSA supports EDUSAT initiatives in states like Madhys Paradesh, Chhatisgarh, Bihar, Uttar Pradesh, Tamil Nadu, Karnataka, Haryana, Andhra Paradesh, etc. Karnataka was one of the earliest states to use teleconferencing model for in-service training of its primary teachers under SOPT programme, and has extended it further over the years. The EDUSAT programme of Karnataka was launched in 2004–05 in collaboration with ISRO and Government of Karnataka and is operational in approximately

885 elementary schools in Chamarajanagar, 885 elementary schools in Gulbarga, 406 elementary schools in Banglore Rural, and 427 elementary schools in Ramanagar covering 3,90,000 children, 13000 teachers and 2000 educational functionaries. Under the SSA Scheme it has been equipped with Receive Only Terminal (ROT) – a solar power pack including one 29'' colour TV with local TV box, UPS and batteries in all schools. 229 ROTs have been provided to all the offices of Deputy Directors of Public Instructions (DDPI), DIETs and Block Resource Centres in Karnataka. The state has organised various teleconferencing programmes and provided in-service training to teachers in very large numbers. For instance, about 45000 –55000 primary teachers teaching English language from classes I-IV were provided training through five teleconferencing programmes . In the year 2008-2009 five teleconference programmes were organised to orient about 1,20,000 teachers across the state, including teachers from aided schools (Kumara, S. 2009). The states of Madhya Pradesh and Gujarat have also utilised the teleconference based in-service teacher training programmes successfully to provide training to teachers on a mass scale. Madhya Pradesh and Chhattisgarh have also organised a number of training programmes for functionaries of Panchayat Raj institutions through the teleconferencing. SSA has been using the teleconferencing facility for training of teachers under four broad themes: building awareness, contextual issues, curricular areas and state specific needs. A number of issues find place in these training programmes such as alternative schooling, academic support to BRCCs and CRCCs, training of VECs, gender issues, education of disabled children, teaching of hard spots, subject specific training, and use of teaching-learning materials, etc.

Gujarat, under the distance education programme of SSA, made extensive use of teleconferencing for state-wide capacity development of various functionaries including the school teachers. Moving a step further, the state government of Punjab set up a registered 'Punjab EDUSAT Society 'in 2007 and has also been organising training of teachers through teleconferencing using the EDUSAT facilities since 2005.

NUEPA has been using two-ways audio and one-way video teleconferencing technology for orientation of field level functionaries working as respondents of District Information System of Education (DISE). In order to avoid any kind of error that could be committed at the stage of filling the DISE DCF and data entry, continuous monitoring, verification and

training is necessary. The number of field level functionaries working as respondents to the DISE DCF are too large and scattered over the country and adopting the conventional cascade model of training is not only time consuming but may also result in loss of information. Teleconferencing, in this context was visualised to be more suitable and has been used since 2008–09 to orient large number of respondents. NUEPA has used the studios of Educational Media Production Centre (EMPC) of IGNOU for training of these functionaries. In collaboration with IGNOU, NUEPA has covered all the states and union territories for training the respondents.

A number of Organisations such as Rehabilitation Council of India (RCI) and National Trust, State Bank of India, IITs, DST, National Council of Science Museum, and National Institutes of Electronics and Telecommunication Engineers, Productivity Council, etc. have also found teleconferencing as a cost effective methodology, training their staff at a mass level.

From Teleconferencing to Video Conferencing

With the advancement of technology, the teacher training programmes using ICT have also witnessed a change from teleconferencing to video conferencing. A video conference (also known as tele videoconference) is a set of technologies which allows two or more locations to interact via two-way audio and video transmissions simultaneously *(http://en.wikipedia.org/wiki/Videoconferencing)*. Teleconferencing has the limitation that the person at the learning end has the facility of two-way interaction, but those at the teaching end have only one-way interaction as they cannot see the learners at the other end. Video-conferencing has provided the opportunity to both teachers and learners to see and interact with each other in real time in spite of physically being located at a distance. Thus, the barrier of geographical distance has been removed by the videoconferencing facility.

The EDUSAT configuration has allowed the educational institutions like CIET, NCERT to develop a network of institutions together constituting a national network. This network facilitates an on demand two-way communication between institutions and within the schools of each institution. CIET (NCERT) has taken an initiative in this regard and entered into an MOU (Memorandum of Understanding) with ISRO for this

purpose. A Ku-Band Sub/Mini Hub has been installed at the CIET along with 100 terminals for installations at different locations in all the states and UTs. This network is being used for undertaking training programmes directly with the target groups as against the conventional approach of training master trainers, key resource persons and then reaching out to the target groups.

NCERT and its Regional Institutes have been using videoconferencing for organisation of training programmes, holding of virtual conferences, exchange of data and other services, viz., linking of libraries and media resources of various Institutions. Through videoconferencing network, NCERT has been organising several programmes for teachers and teacher educators of the country. Most significant among these are orientation of teachers of Kendriya Vidylayas, Navodaya Vidyalayas and schools affiliated to the CBSE Board on the textbooks developed based on the National Curriculum Framework (NCF 2005), Orientation of Principals and Head Teachers of KVs on NCF 2005; orientation of teacher educators of DIETs, SCERTs, CTEs and IASEs on NCF 2005, orientation of teachers on gender issues, orientation of teachers and teacher educators on new trends in evaluation and a number of subject-specific training programmes, etc. Therefore, for the first time teachers from different parts of the country interacted directly with the textbook writers/developers, experts in different subject areas, and the policy planners concerned with curriculum, syllabi and the textbooks. During these orientation programmes the participants got opportunity to put forward their reflections, views, observations, suggestions and also questions/queries on different aspects of curriculum framework, syllabi, textbooks and practical aspects related to transaction of the curriculum to satisfy their curiosity and clarify their concepts. Expert panelists provided answers to their questions/queries within the time available to them. These programmes provided new experiences covering important aspects of NCF-2005, syllabi, textbooks and other related aspects with large but structured participation of experts and teachers.

Challenges in using interactive technology for teacher training

Use of teleconferencing and videoconferencing as a means for capacity building of teachers has revolutionised the process of continuous professional development of teachers and has ensured access to equal quality of training

and teaching inputs for each and every one participating in the programme, rendering remoteness of geographical locations meaningless. However, the efficiency and effectiveness of teleconferencing are perferred because of the way the content is organised and presented, the efficiency of the resource persons, appropriateness of activities for achieving the objectives, and implementation of strategies that increase interaction and participation, etc. (Rao & Khan, 1998; Khan, 2000; Trivedi, 2004; Balaouras, 2008; Agorogianni, Zaharis & Goudos, 2008; Kalogiannakis & Vasilakis, 2008). The issues of emulating a conventional classroom through in a teleconferencing programme, lack of opportunity for interaction due to increase in the number of learners/participants at the learning end and technical issues such as quality of reception of picture and sound, constant power failure, disturbance in telephone lines and non-functioning or non-availability of telephone lines or fax facilities need to be addressed to improve the quality of ICT-based teacher education programme for capacity development of teachers.

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Brief Profile of the Editor and Authors

Manas Ranjan Panigrahi, Ph.D. joined the Commonwealth of Learning (COL) as Programme Officer (Education) of the Commonwealth Educational Media Centre for Asia (CEMCA), New Delhi, India on May 2014. Before joining CEMCA he served in the Department of Educational Planning and Management, College of Education and Behavioural Sciences, Haramaya University, Ethiopia, East Africa as Associate Professor in Education from 2010-2014. Dr. Panigrahi has also served Indira Gandhi National Open University (IGNOU), National Council for Educational Researchand Training (NCERT), and Manav Rachna International University, amongst others in different capacities. Dr Panigrahi has over 15 years of experience in research, design & development and teaching at under-graduate and post-graduate level of teacher education. With a blend of academic and professional qualifications in teacher education, distance education and training and development he has been promoting the use of Information Communication Technology (ICT), and use of Open Educational Resources (OER) around the world. Dr. Panigrahi has published number of research articles, conceptual papers, monographs on education and educational technologyand authored various reports/policy papers for national and international level institutions. Organised and attended various academic workshops/training programmes/professional events/ expert committee meetings, teleconferencing, video conferencing, audio and video production and conferences. Delivered lectures at various places in the country and abroad and presented papers in various national/ international conferences. His areas of interest are extensive use of ICT in education, educational technology and higher education and open and distance learning. He can be reached at mpanigrahi[at]col[dot]org.

Som Naidu, D.Litt. has spent much of his professional life in the higher education sector, in a variety ofroles and in different jurisdictions, to do with enhancing learning and teaching practices, curriculum design and development and online learning and teaching. Currently a Monash University Affiliate, most recently Dr. Naidu served as Associate Professor (Learning Transformations), at Swinburne University of Technology in

Melbourne, Australia. From October 2008 to April 2013, he served as Associate Professorand Director of Teaching and Learning Quality Enhancement and Evaluation Services at Charles SturtUniversity. Prior to that he served 11 years at the University of Melbourne as Associate Professor of Educational Technology and Multimedia Education and Head of Research and Evaluation. Dr. Naidu earned Ph.D. in Educational Technology (curriculum and instructional design and distance education) from Concordia University in Montreal, Canada, and received D.Litt. in 2014 from Open University of Sri Lanka. Dr. Naidu is current president of the Open and Distance Learning Association of Australia, and serves as Executive Editor of its journal – Distance Education. He can be reached atsommnaidu[at]gmail[dot]comandsomaiya[dot]naidu[at]monash [dot]edu[dot]au.

Matthew J. Koehler is professor of educational psychology and educational technology at the College ofEducation at Michigan State University, where he co-directs the doctoral program in Educational Psychology and Educational Technology. His scholarly interests include the pedagogical affordances (and constraints) ofnewer technologies for learning, specifically in the context of the professional development of teachers. Hemay be found at http://mkoehler[dot]educ[dot]msu[dot]edu.

Punya Mishra is professor of educational psychology and educational technology at the College of Educationat Michigan State University, where he also co-directs the Master's program in Educational Technology. Hisscholarly interests include technology integration in teaching and learning, creativity and design. He may be found at http:// punyamishra.com/ and punya[at]msu[dot]edu.

Mete Akcaoglu is a doctoral student of educational psychology and educational technology at the College of Education at Michigan State University. His scholarly interests include the design and evaluation of technology rich and innovative learning environments for K-12 children. He may be found at http://meteakcaoglu[dot]com.

Joshua M. Rosenberg is a doctoral student of educational psychology and educational technology at theCollege of Education at Michigan State

University. His scholarly interests include the sociocultural effects ofteaching and learning with technology. He may be found at http:// studydesigned[dot]com.

Manoj Kumar Dash is Regional Director at Regional Centre Jaipur of Indira Gandhi National Open University (IGNOU), Rajasthan, India. He started his professional carrier in the field of teacher education as a Lecturer in Education from Tara Tarini College, purushottampur, Under Berhampur University, Odisha in 1999. During his tenure as lecturer he has also been working as visiting faculty to various study centres of MP Bhoj Open University to teach B. Ed. Special Education and D.Ed. Special Education. In 2005 he joined in DEP-SSA, IGNOU, A MHRD-Govt. of India Project as a consultant and subsequently posted as Programme Officer in 2007 in the same Project. He was extensively associated with training, orientation, capacity building of teacher educators, teachers and other field functionaries in all states of India. He was involved in research, impact feedback studies and contributed significantly in various research projects at national level and also at state level in collaboration with various state Governments. He was authored 42 research papers/articles published in different journals of national and international repute in teacher education and contributed 18 Units to different self-learning materials (SLMs) for training of teachers and teacher educators. Dr Dash contributed to study materials of IGNOU and VMOU, Rajasthan. Besides he published four books on educational technology, inclusive education, community based rehabilitation, and primary education in India. He can be reached at drdash72[at]yahoo[dot]co[dot]uk and drdash[at]ignou[dot]ac[dot]in.

Andrew Moore completed a M.Ed. specializing in Computer Assisted Education at the University of Pretoriain 2002. Andrew has worked at Neil Butcher and Associates since 2005 managing projects designed toprovide capacity to staff at higher education institutions to design, develop and deploy e-learning solutions. Other projects focus on providing capacity to identify, adapt, and share OER.

Neil Butcher is based in South Africa, from where he has provided policy and technical advice and supportto a range of national and international clients regarding educational planning, uses of educational technology and distance education. He has worked with various educational institutions,

assisting with transformation efforts that focus on effectively harnessing the potential of distance education methods, educational technology, and OER. Neil has travelled extensively through the world conducting research on higher education, distance education, and educational technology for a range of organizations, governments, and donors. He can be reached atneilshel[at]nba[dot]co[dot]za.

Sarah Hoosen has a Masters' Degree in Social Science in Counseling Psychology, and is currently working atNeil Butcher and Associates as a researcher and project manager. She has been involved in evaluating anumber of projects in the area of education and technology, and has published a number of papers ondistance education and open educational resources.

Saroj Pandey is Professor in the School of Education at Indira Gandhi national Open University (IGNOU).She has widely contributed at the national and international level and has more than hundred national andinternational publications to her credit. She has 25 years of teaching and research experience in the area ofeducation and teacher education. Her area of interest includes teacher education, elementary education,human rights and peace education, and distance education. She can be reached at spandey[at]ignou[dot]ac[dot]in.

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