Lecture Notes in Educational Technology

Daniel Churchill
Jie Lu
Thomas K.F. Chiu
Bob Fox *Editors*

Mobile Learning Design

Theories and Application

Springer

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Foreword

What Will They Think of Next?

This book arrives at an exciting time. The technology stories that circulate in the media talk about access through WIFI anywhere and diminishing (or at least increasing variability of) device size. So it is not unexpected that a group of scholars should start discussing the possibilities and opportunities of such developments in how we can learn and collaborate in such a digital world that has broken away from traditional classrooms. Daniel Churchill, his co-editors and the contributors have created a text that summarises what designers and researchers believe are the range of influences that this emerging field is facing. In the first part of six sections, the chapters deal with the definitional and emerging nuances being identified with the field of study. The key concepts are not unexpectedly: mobility, interactivity and collaboration, and augmentation. But as the later chapters explore it is also about how the world can be represented, accessed and overlaid with digital support. Overall, the opportunities of mobile learning and the barriers it breaks by social and other forms of communication and collaboration promise more that the rather limited and still largely didactic e-learning models available in many educational ecosystems.

In the second part, the focus shifts to the current adoption of mobile learning and how students perceive its value. Importantly, trends that have been noted here have been the possibilities of working on real-world contexts with overlays of digital structures and mentoring. The third part explores the combination of technology, pedagogy and context improving the flexibility of the new mobile learning contexts to provide increasing student personalization and to collect data of individual learning styles and strategies. This long hoped for adaptive learning system approach has been a goal of learning technologies for many years but it has largely eluded many designers; the different chapters illustrate how mobile learning contexts support collaboration and sharing in ways that have not been designed into most standard eLearning contexts.

The next two sections of this book focus on how mobility and the combination of technologies can "fit" in learning broadly and in specific discipline domains. The writers have written about particular strategies and the "fit" with each discipline. This emphasis is important, early approaches to learning science did not identify the importance of domain knowledge and how it could be could supported and enhanced with the combination of elements—technology, learning approach and pedagogical context.

In the last section, the one chapter seeks to explore how future options might influence how mobile approaches might effectively support learning in a digital age. In this summarization, the possibilities of mobility and smart devices support a learner to explore their world by providing an organising lens to display the evidence and to aggregate it in ways that support the learner's meaning-making. I believe that the chapter raises both the plus and minus sides of this new learning ecology; this combination enables convenience of access to ideas and tools to support creation of many ways and modalities of representing them, and also to the increasing loss of personal privacy as the learner collates and makes sense of the phenomena they are studying. Overall, this book pulls together all of the elements that have been used as a solution to student motivation, increasing impact, supporting diversity and enabling personalization of the tools that support mLearning.

John G. Hedberg
Macquarie University

Preface

This book has been written and published at the time of growing interest in and a need for mobile learning in education at all levels. The chapters in this book are primarily concerned with theories and practices related to the adoption of mobile and emerging technologies in education. These chapters are collected from three sources. The first source comprises a pool of papers directly submitted for consideration for inclusion in this book. The second source includes papers from a small number of invited authors. The third source comprises a small number of rigorously selected papers from the pool of papers presented at the International Mobile Learning Festival (IMLF). The IMLF conference is a regular international gathering of scholars and educational practitioners interested in mobile and emerging learning design. The conference features evidence-based developments surrounding mobile and emerging learning design for the twenty-first century learning.

Educational usages of e-books, streaming videos, podcasts, social networking, cloud computing, blogs, multimedia and video editing and many other mobile applications have been adopted by innovative educators and institutions around the world. To scale-up these innovative practices mediated by mobile technologies, there is a pressing need to harness research studies with a solid theoretical underpinning, and empirically validated practical recommendations to inform research, practices and policies. The purpose of this book, therefore, is to update contemporary developments surrounding theories and applications of mobile technologies in education at all levels. In particular, attention is given to emerging learning design models as well as exemplary cases of adoption of mobile technologies.

It can be suggested that mobile technology today offers a spectrum of tools for teachers, educational opportunities as well as new options for student–technology partnerships in learning. Empowered with interactive multimedia presentational capabilities, handheld technology permits the delivery of a range of multimedia material such as video, audio, graphics and integrated media. When appropriately designed for the context, educationally useful digital resources for learning can be effectively delivered via mobile technologies to students at any time, inside and

outside of classrooms. The powerful technical features of mobile technologies, and available mobile applications powered with social media and cloud computing enable new forms of learning platforms which can serve contemporary pedagogies across a variety of educational contexts (see Churchill and Churchill 2008; Evans 2008; Kaleebu et al. 2013, Lai et al. 2007).

Relevant studies report a variety of issues in relation to use of mobile technologies in education. Examples of issues reported include use of mobile technology during classes, enabling teachers and students to share files; allowing students to ask anonymous questions, answer polls and give teachers feedback (e.g., Ratto et al. 2003); deliver an intelligent tutoring systems and quizzes (e.g., Segal et al. 2005); the dissemination information, the collection data during field trips and the support of students' inquiries (e.g., Churchill et al. 2010; Jong and Tsai, in press); supporting computer collaborative learning (e.g., Roschelle and Pea 2002; Zurita and Nussbaum 2004); using mobile instant messenger to support second language learning (Lai, in press); the improvement of literacy and numeracy for disadvantaged young adults (Attewell 2005); as a personal technology for lifelong learning (Sharples 2000); as personalized learning environments (e.g., Song and Fox 2008); as instructional tools and a replacement to laptops (e.g., Shen et al. 2009); as a tool for learning on the move (e.g., Wong et al. 2010); as a mediating tool for ubiquitous, seamless, authentic and situated learning experiences, (e.g., Hedberg 2014; Looi et al. 2010; Wong and Looi 2011), teacher use of iPads as a transformative strategy (Churchill and Wang 2014), and so on. Liu et al. (2014), who conducted a comprehensive analysis of the literature on mobile learning from 2007 to the present, argue that the most contemporary studies explore issues from four distinct perspectives, which include comparison studies (e.g., studies of learning outcomes), non-comparison studies (e.g., studies of communication and collaboration with mobile technology), mobilized learning studies (e.g., studies of learning outside of classrooms) and academic content studies (e.g., studies of mobile technology in natural science education).

For Liu et al. (2014), the key problem with the research and practice on mobile learning is a weak connection and even complete absence of any connection to learning theories. This connection is essential if the new theoretical frontiers and affordances of mobile technology are to be explored. Therefore, for the effective integration of mobile technology in education, an appropriate learning design that builds on sound learning-theoretical foundation is essential. From the literature, it has been suggested that mobile learning has been designed according to three paradigms, including (see Churchill et al. 2014): "learning with mobile technologies" (e.g. Anderson and Blackwood 2004; Churchill and Churchill 2008; Song and Fox 2008), "learners on the move" (e.g., Gu et al. 2011; Seppälä et al. 2003; Wong et al. 2010), and "dynamic, seamless and ubiquitous learning experiences" (e.g., Wong and Looi 2011; Kearney 2014; Song 2014; Ting 2013). For Churchill, Lu and Chiu (2014), the most critical aspect of effective mobile learning today is integration of mobile technology, social media and a learning design. A learning design should serve as a powerful intervention strategy to transform teacher thinking in a productive direction (e.g., Churchill et al. 2013; Churchill, Fox and

King, Chapter 1 in this book). This book proposes the RASE learning design framework, which emphasizes four core components to a mobile-enabled learning environment, namely resources, activity, support and evaluation.

This book comprises 24 chapters written by authors and co-authors from across the world. The book is sorted into the main six parts as follows:

- Mobile Learning Design—explores learning design frameworks and approaches for integration of mobile and emerging technologies in education, including the RASE (Churchill, Fox and King), authentic learning approaches (Burden and Kearney), social media and collaboration (Cochrane and Narayan) and Activity-theoretical perspective (Rozario, Ortlieb and Rennie). An additional chapter by Notari and Hielscher provides a useful classification/ontology of educational Apps. Understanding of this ontology might contribute to a more effective integration of Apps into learning designs. The final chapter by Kidd and Crompton explores augmented reality, its affordance and possibilities for application via mobile learning technologies.
- Mobile Learning Adoption and Student Perception—attention is given to the issues of acceptance, adoption and student perception related to educational integration of mobile learning technology. The issues addressed include adoption factors (Balakrishnan and Lay), student conception of mobile learning (Khan, Abdou and Clement), student concerns and attitudes (Putnik), and student usage and perception (Hu et al.). The chapters in this part provide unique perspectives on some specific applications of mobile technology, such as in interactive lectures, and integration with a learning management system.
- Mobile Learning Analytics—examines the important and increasingly emerging issue of learning analytics, and explores how mobile technology might be adopted to provide more systematic understanding of student engagements. Tam, Yi, Xu and Lam explore learning analytics in the context of application of a cloud-based technology platform, while Wong provides a unique perspective on "flipped classrooms", and how mobile technology might assist the process of examining student learning.
- Mobile Learning Across the Curriculum—explores the integration of mobile technology across the curriculum and educational entities. This part explores integration into K-12 education (Turner; Wang), early childhood education (Tavernier), out-of-the-class learning (Hayes and Weibelzahl) and workplace learning (Gu). Though there is no specific focus on higher education in this part, the concepts and ideas introduced are highly applicable and useful to this sector.
- Mobile Learning in Subject Domains—provides more specific perspectives on the integration of mobile technology in specific curriculum areas and topics, including Geometry (Crompton), Healthcare (Cook and Santos), college English education (Wang and Cui), English vocabulary learning (Sytwu and Wang) and Mathematics (Khoo; Chiu). This part highlights the need for further research and documentation of practices in the development of emerging literacies related to mobile learning. For now, however, the reports on English and Mathematics education appear to dominate the discussion.

- Future Development—a single chapter by Pegrum is included in this part. The chapter offers an outstanding conclusion to the ideas presented in this book and sets the context for further development, underlining various aspects and factors surrounding effective adoption of technologies in education.

In summary, contemporary mobile technologies offer a set of tools and affordances for the advancement of teaching and learning. Furthermore, research and practice should incorporate not just mobile technology, such as smartphones and tablets, but the need to follow developments with emerging technologies, such as a variety of wearable devices (e.g., glasses and watches), "internet-of-things" and other emerging technological innovations that introduce and make possible educationally useful affordances at new levels. A stronger connection between mobile technology integration and learning-theoretical frameworks is essential to guide research, practice and policy. Rather than focusing on technology, a key proposition of this book is to lead education integration of mobile and emerging technologies through an appropriate evidence-based learning design framework. Equally important is the achievement of curriculum specified outcomes; the development of new literacies; learner satisfaction; relevance of educational activities given the work practices of young individuals; and more effective work management, change and performance by teachers. The potential of intellectual partnerships with mobile and emerging learning technologies is promising, however, without empirical research input, a learning design framework and relevant policy, success will be hard to realise. Further studies are required to investigate aspects of such methodologies, framework and policies. In addition, research needs to pay attention to aspects of the design of mobile learning Apps across various categories ranging from multimedia content, communication, digital storytelling to social networking and cloud computing.

In conclusion, on behalf of the editorial team, I wish to give special thanks to the authors and reviewers of the papers, and others who assisted in the development of this project. Working with more than 35 authors and co-authors from across the world has been a challenging but rewarding experience for the editorial team. Special thanks to the Mobile Learning Faculty Research Theme of the Faculty of Education, The University of Hong Kong, Consultants International for Human Development and the International Mobile Learning Festival for the support invested in this project. In the future we intend to expand this collection through further involvement with scholars and practitioners and their participation in forums such as the IMLF conference. I am sure that this book will contribute to the advancement of knowledge and practice in the implementation of mobile and emerging learning technologies.

Daniel Churchill

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Daniel Churchill is an Associate Professor at the Faculty of Education, The University of Hong Kong. He has been teaching for more that two decades at universities around the world, including Europe, Australia and Asia. He specialises in educational technology, education system development, and multimedia design. Over the years, he has been active in researching topics including learning 2.0, mobile learning, e-learning instructional design, learning objects, and teacher professional development. He is a recipient of a prestigious "HKU Outstanding Teacher Award," and "the Macromedia's Award for the Best Multimedia on the Internet." Also, Dr. Churchill is active as a novelist, and his latest novel "The Refugees" has been published and distributed globally in 2015.

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Part I
Mobile Learning Design

Chapter 1
Framework for Designing Mobile Learning Environments

Daniel Churchill, Bob Fox and Mark King

Abstract In this chapter the RASE learning design framework is proposed as a key strategy for utilizing multiple affordances of mobile learning technology. This learning design framework is based on the premise that an effective learning environment must include and integrate at least four core components, namely: Resources, Activity, Support and Evaluation. The activity component is the most important, requiring students to engage with intellectual and knowledge-based developments. Mobile technology offers a number of affordances that support learning, including: Resources, Connectivity, Collaboration, Capture, Representation, Analytical and Administration tools. Effective use of mobile technology includes deployment of these affordances in the learning design in a way that supports different components of the RASE framework and achievement of set learning outcomes. This chapter presents and discusses concepts, arguments, and a discussion of an example of an app that integrates multiple affordances, supported by all components of the RASE learning design framework.

1.1 Introduction

Mobile devices such as tablets, mobile phones and iPods are being increasingly used in education around the world. Since 2011, the annual Horizon Report has emphasized the importance of mobile technology, and coupled with cloud computing, these technologies will continue to have a major impact on education

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(see New Media Consortium 2011). Educational uses of, for example, e-books, digital videos, podcasts, social networking, cloud computing, and many other mobile apps have been adopted by different groups of innovative educators and institutions around the world.

Mobile technology offers a spectrum of tools for teachers, twenty-first century educational opportunities and new options for student-technology partnerships in learning. Empowered with interactive multimedia presentational capabilities, mobile technology enables the delivery of a range of multimedia material such as video, audio, graphics and integrated media. If appropriately designed for the context, educationally useful digital resources for learning can be effectively delivered via mobile technologies to students at any time, inside and outside classrooms. Furthermore, features of mobile technologies, and available mobile applications powered with social media and cloud computing enable new forms of learning platforms that can serve in a variety of educational contexts (see Churchill and Churchill 2008; Evans 2008; Lai et al. 2007). However, for Liaw et al. (2010) although mobile technologies have power to improve education, there is a lack of recommendations for educators, as the current research and practical recommendations are still in an embryonic stage. For Churchill et al. (2014), mobile learning has been designed following three paradigms, including: 'learning with mobile technologies' (e.g. Anderson and Blackwood 2004; Churchill and Churchill 2008; Song and Fox 2008), 'learners on the move' (e.g. Gu et al. 2011; Seppälä and Alamäki 2003; Wong et al. 2010), and 'dynamic, seamless and ubiquitous learning experience' (e.g. Wong and Looi 2011; Kearney 2014; Song 2014; Ting 2013). However, we find these paradigms to be incomplete, and that a more comprehensive and applicable framework for learning design is needed to provide teachers, educational policy-makers and researchers with a representation of how affordances of emerging technologies can be utilized in the context of teaching and learning. In this chapter, we explore the RASE (Resources-Activity-Support-Evaluation) learning design framework (see Churchill et al. 2013), and discuss how it can be utilized to integrate affordances of mobile technologies in a learning environment.

1.2 RASE Learning Design

The central idea behind the RASE learning design framework is that *Resources* are not sufficient for full achievement of learning outcomes. In addition to resources, teachers need to consider the following:

- *Activity* for students to engage in using resources and working on tasks such as experiments and problem solving leading through active experience towards achievement of learning outcomes.
- *Support* to ensure that students are provided assistance, and where possible with tools to independently or in collaboration with other students, solve emerging difficulties.

- *Evaluation* to inform both students and teachers about progress and to serve as a tool for understanding what else needs to be done in order to ensure learning outcomes are achieved.

Figure 1.1 is a visual representation and summary of the RASE learning design.

The RASE learning design framework builds upon important theoretical work and concepts described below.

- *Constructivist learning environment* (Jonassen 1999). In this view, learning should be arranged around activities, and occur in an environment that supports knowledge construction, as opposed to knowledge transmission. Knowledge construction is a process where students individually construct their understanding of the content of the curriculum based on exploration, social engagement, testing of understandings and consideration of multiple perspectives.
- *Activity Theory* (Engeström 1987). Activity Theory specifies the components that are part of a human activity system. To understand what is learning, it is important to understand the specifics of this activities, as well as tools used in the process, the rules and the division of labor, community involved in the process, parallel and vertically related activities, interactivity, and contradictions.
- *Problem solving* (Jonassen 2000). For Jonassen, learning is most effective in the context of the tasks in which students engage to solve ill-structured, authentic,

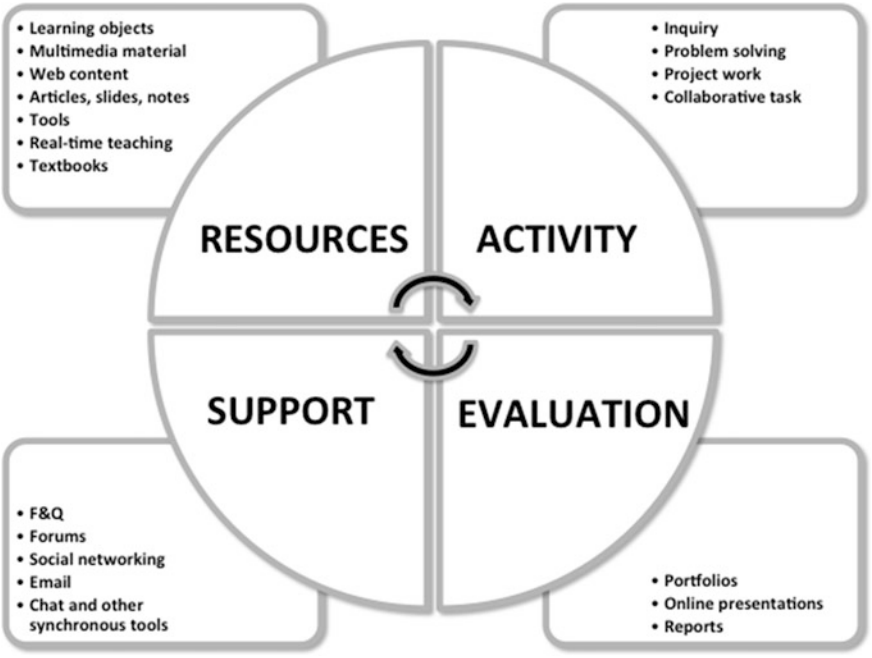

Fig. 1.1 The RASE learning design

complex and dynamic problems. These kinds of problems are significantly different from logical, well-structured problems with one solution. These types of problems are dilemmas, case studies, strategic decision-making and planning, all of which require students to actively engage in deep reflection, consideration of theoretical perspectives, the use of tools, creation of artefacts and analysis of various possible solutions. Students learn through complex problems, and not through the absorption of ready-made knowledge, rules and procedures.

- *Problem-based learning (PBL)* (Savery and Duffy 1995). Savery and Duffy propose PBL as an optimal design model for student centred learning. Similar to those approaches above, the PBL builds upon constructivist philosophy and contends that learning is a process of knowledge construction and social co-construction. A key feature of the PBL is that students actively work on authentic tasks, and construct knowledge in contexts that reassemble those in which they would use that knowledge. Creativity, critical thinking, metacognition, social negotiation, and collaboration are all perceived as a critical component of a PBL process. One of the key characteristics of PBL is that teachers should not primarily be concerned with the knowledge students' construct, but should focus, more attention to metacognitive processes.
- *Rich environments for active learning* (Grabinger and Dunlap 1997). Similar to Savery and Duffy, Grabinger and Dunlap propose PBL as a highly effective educational intervention. However, in their approach, further attention is given to the context of the environment in which PBL occurs, considering components and complexities that such an activity requires. In particular, emphasis is placed upon making students more responsible, willing to provide initiatives, reflective and collaborative in the context of dynamic, authentic and generative learning. This approach also emphasizes the importance of the development of lifelong learning skills.
- *Technology-based learning environments and conceptual change* (Vosniadou et al. 1995). In this view, the central role of technology is to support students' conceptual changes and concept learning rather than simple knowledge transfer. Students construct mental models and other internal representations via attempts to explain the external world. Students often bring prior misconceptions to learning situations.
- *Interactive learning environments* (Harper and Hedberg 1997; Oliver 1999). Oliver proposes that a learning module must contain resources, tasks and support to serve the complexity required for learning. For learning to take place, a task must engage students to make purpose-specific uses of resources. The teacher's role is to support learning. These three integrated components will lead to interactivity essential for learning.
- *Collaborative knowledge building* (Bereiter and Scardamalia 2003). Knowledge building is a theoretical construct developed by Bereiter and Scardamalia to provide interpretation of what is required in the context of collaborative learning activity. Personal knowledge is seen as an internal, unobservable phenomenon, and the only way to support learning and understand what is taking place is to deal with so-called public knowledge (which represent what a community of

learners know). This public knowledge is available to students to work on, expand and modify through discourse, negotiation, and collective synthesis of ideas.

- *Situated learning* (Brown et al. 1989). Brown and colleagues build upon the Activity Theory perspective to emphasize the central role of an activity in learning. An activity is where conceptual knowledge is developed and used. It is argued that this situation produces learning and cognition. Thus, activity, tools and learning should not be considered as separate. Learning is a process of enculturation where students become familiarized with uses of cognitive tools in the context of working on an authentic activity. Both activity and how these tools are used are specific to a culture of practice. Concepts are not only situated in an activity, but also are progressively developed through it, shaped by emerging meaning, culture and social engagement. Brown and colleagues strongly suggest that activity, concept and culture are interdependent, in that "the culture and the use of a tool determine the way practitioners see the world, and the way the world appears to them determines their cultural understanding of the world and of the tools… To learn to use tools as practitioners use them, a student, like an apprentice, must enter that community and its culture" (p. 33). Hence learning is a process of enculturation, where students learn to use a domain's conceptual tools in an authentic activity.

What can be observed from these theoretical approaches is that an Activity is central to learning. Learning is an experience where learners construct and use knowledge. Furthermore, each of the four components of the RASE is discussed is more details.

1.2.1 Resources

Resources include (a) content (e.g. digital media, textbooks and a lecture by a teacher), (b) material (e.g. chemicals for an experiment, paint and canvas) and (c) tools that students use when working on their activity (e.g. laboratory tools, brushes, calculators, rulers, statistical analysis software and word processing software). When integrating technology resources in teaching, it ought to be done in a way that leads students to learn with, rather than just learn from these resources. In this way, students can develop elements of their overall new literacies. There are various software tools that students can use in learning (e.g. Mind Mapping tool such as MindMeister, image/video editing tool such as iMovie, professional tools such as AutoCAD and Mathematica, and model building and experimentation tools such as Interactive Physics and Stella).

1.2.2 Activity

An activity is a critical component for the achievement of learning outcomes. It provides learners with an experience where learning occurs in context of emerging understanding, testing ideas, generalizing and use of knowledge. The following are two key characteristics of an effective activity. An activity must be 'learning-centred'

- It must focus on what learners will do to learn, and how their rather conceptual changes will develop, rather than on what students will remember to reproduce at examinations.
- Resources are tools in students' hands, which assist them to complete tasks.
- Teachers are facilitators who participate in the learning process as partners and critical friends.
- Learners produce artefacts that demonstrate their learning process, not just outcomes.
- Learners learn about the process by actively experimenting with approaches and reflecting on effective strategies (metacognition).
- Learners develop new literacies required for twenty-first century learning, working and living.

Furthermore, an activity must be 'authentic'. This means that:

- It should contain real-life scenarios and ill-structured problems.
- It should reassemble professional practice and thinking.
- It should use tools specific to professional practice.
- It should result in artefacts that demonstrate professional performance (intellectual and practical knowledge use), not only knowledge.

The following are examples of what an activity may be:

- A design project (e.g. design an experiment to test scientific hypothesis).
- Case study (e.g. a case of how a scientist identified new physics regularity).
- A problem solving learning task (e.g. minimizing friction in a design of ski).
- Develop a documentary movie on a specific issue of interest (e.g. GM food pros and cons).
- A poster to promote a controversial scientific issue (e.g. Nuclear energy).
- Planning a history day in your school (e.g. create a model and display to inform about ancient Egyptian culture).
- Develop as software to control mechanical transfer of power (e.g. use Scratch to design a digital model to assist an analytical task)
- Role-play (e.g. defending science experiment with small animals).

1.2.3 Evaluation

An activity engages learners in working on tasks, and developing artefacts that evidence their learning. This evidence of student learning enables the teacher to monitor student progress and provide further formative guides to help improve students' learning achievement. Outcomes of an activity can be a conceptual artefact (e.g. an idea or a concept presented in a written report), a hard artefact (e.g., a model of an electric circuit), or a soft artefact (e.g. a computer-based creation). Artefacts produced by students must undergo peer and expert review and a revision before final submission. This process may also involve learner/group presentations and peer/expert feedback. Also, students need to record their progress, so they too can monitor own learning and the improvements they make. Rubrics can be provided to enable students to conduct self-evaluation as well. The produced artefacts ought to be evaluated in ways that students can reflect upon feedback and take further action towards a more coherent achievement of the learning outcomes. Evaluation of learning is an essential part of effective learning-centred experiences. It needs to be formative in order to enable students to constantly improve their learning, and provide feedback on progress.

1.2.4 Support

The purpose of support is to provide students with essential scaffolding while enabling the development of learning skills and independence. Support might anticipate students' difficulty, such as understanding an activity, using tool or working in groups. In addition, teachers must track and record ongoing difficulties and issues that need to be addressed during learning, and share these with students. Four modes of support are possible: teacher-student, student-student, student-artefact (additional resources) and student-community (seeking assistance from other people and sources). Support can take place in a classroom and in-online environments such as through forums, Wikis, Blogs and social networking spaces.

Also, support can be seen as anticipatory of student needs. Depending on the course, proactive support structures such as FAQs can be planned and implemented in light of such needs. The objective of anticipatory support is to ensure students have access to a body of resources when they need help, rather than being dependent on asking teachers for help. Here are some specific strategies:

- Build a body of resources and materials which form a FAQ Page
- Create a "How Do I?" or "Help Me" Forum
- Create a Glossary of course-related terms
- Use checklists and rubrics for activities
- Use other social networking platforms and synchronous tools such as chat and Skype.

Overall, support should aim to lead students to become more independent learners. For example, before a student can ask a teacher for help, they must first ask their classmates through one of the forums and/or search the Internet for solutions to their problem(s). In this way, students are expected to take responsibility for their learning and to support other students in their cohort.

Designing learning environments based on the RASE, whether for online, blended or classroom based learning, should have integration of all four components. Learning design usually begins by articulation of an activity for learners to engage. Planning evaluation would then take place, followed by provision of resources and support.

Furthermore in this chapter, possibilities of how mobile learning might support the RASE will be examined through consideration of affordances of mobile technology.

1.3 Affordances of Mobile Learning Technologies and the RASE Learning Design

Studies report a variety of possibilities in relation to use of mobile technologies in education. Examples of issues reported include: use of mobile technology during classes, enabling teachers and students to share files; allowing students to ask anonymous questions, answer polls, and give teachers feedback (e.g. Ratto et al. 2003); delivering an intelligent tutoring system and quizzes (e.g. Segal et al. 2005); disseminating information, collecting data during field trips and supporting students' inquiries (e.g. Churchill et al. 2010); supporting computer collaborative learning (e.g. Roschelle and Pea 2002; Zurita and Nussbaum 2004); improving literacy and numeracy for disadvantaged young adults (Attewell 2005); as a personal technology for lifelong learning (Sharples 2000); as a personalized learning environments (e.g. Song and Fox 2008); as instructional tool and a replacement to laptops (e.g. Shen et al. 2009); as a tool for learning on the move (e.g. Wong et al. 2010); as a mediating tool for ubiquitous, seamless and situated learning experiences, (e.g. Looi et al. 2010; Wong and Looi 2011), and so on.

An affordance is a useful concept that can be applied to interpret how teachers engage technology in their practice. Norman (1988) defines affordances as "the perceived and actual properties of the thing, primarily those fundamental properties that determine just how the thing could possibly be used" (p. 9). For Barnes (2000), a teacher's use of new technology in teaching and learning is carried out with a belief that this technology will afford learning in some way. Affordances can include actual uses, and those uses that emerge in teachers practice. Therefore, how mobile technology will be used in education depends largely on teachers' understandings of affordances of this technology.

What do we know about educational affordances of mobile technology at this stage? The literature related to early adoption of mobile technology suggests that it

might assist students to learn anytime, anywhere, by empowering them "to access internet resources and run experiments in the field, capture, store and manage everyday events as images and sounds, and communicate and share the material with colleagues and experts throughout the world" (Sharples et al. 2002, p. 222). For Luchini, Quintana and Soloway (2004), the key benefit of such mobile technology is that powerful personal devices can "provide access to tools and information within the context of learning activities" (p.135). For Hsieh, Jang, Hwang and Chen (2011) mobile technology has potential to support students' reflection leading to improved learning achievement when there is an appropriate match between a teacher's teaching style and students' learning style.

Klopfer and Squire (2005) describe five potential educational affordances of PDAs: (1) portability, as mobile technology can be taken to different locations; (2) social interactivity, as mobile technology can be used to collaborate with other people; (3) context sensitivity, as mobile technology can be used to gather real or simulated data; (4) connectivity, as mobile technology enables connection to data collection devices, other handhelds, and to a network; and (5) individuality, as mobile technology can provide scaffolding to the learners. Patten, Sánches and Tangney (2006) present a framework that consists of the following affordances of PDA technology: administration, referential, interactive, microworld, data collection, location awareness and collaboration. Liaw, Hatala and Huang (2010) suggest five affordances of mobile technology for education: (a) educational content and knowledge delivery, (b) adaptive learning applications, (c) interactive applications, (d) individual applications and (e) collaborative applications. Churchill and Churchill (2008) expanded upon these studies and examined a teacher's use of PDA technology. Their study articulated a number of affordances of PDA technology including as a multimedia access, connectivity, capture, representational and analytical tool. In our own study of teacher use of iPads in higher education (see Churchill and Wang 2014), we explicated a set of categories of apps utilized by educators. These include: (a) productivity, (b) teaching administration, (c) note taking, (d) communication, (e) cloud management, (f) social content creation and (g) content accessing tools.

These affordances from these reports are sorted through our analysis into emerging groups of affordances that include (see Table 1.1): (a) resources tool, (b) connectivity tool, (c) collaboration tool, (d) capture tool, (e) analytic tool, (f) representation tool, and (g) administration tool. These groups are used as an analytical framework for understanding affordances that emerge in this study.

The following is a brief description of these key affordances of mobile technology:

- *Resources* A variety of multimedia resources can be delivered using this technology, such as e-books, web pages, presentations, interactive resources, audio files and video segments. These resources can be accessed at anytime, anywhere, by connecting to the Internet mobile network or wireless network connections, from the memory of the device or storage card if the resources were previously downloaded, or through synchronization of the device with a

Table 1.1 Affordances of mobile learning technology

Klopfer and Squire (2005)	Patten et al. (2006)	Churchill and Churchill (2008)	Liaw et al. (2010)	Churchill and Wang (2014)	Summary of affordances emerging from across these studies
Portability	Administration (7)	Multimedia access (1)	Educational content and knowledge delivery (1)	Productivity tools (3, 6)	1. Resources
Social interactivity (3[a])	Referential (1)	Connectivity tool (2)	Adaptive learning applications (1)	Teaching Administration tools (2, 7)	2. Connectivity
Context sensitivity (4)	Interactive resource (1)	Capture tool (4)	Interactive applications (3)	Note taking tools (4, 6,)	3. Collaboration
Connectivity (2, 3)	Microworld environment (1)	Representational tool (6)	Individual applications (6)	Communication tools (2, 3)	4. Capture
Individuality (1)	Data collection (4)	Analytical tool (5)	Collaborative applications (3)	Cloud management tools (3, 4, 7)	5. Analytical
	Location awareness (4)			Social content creation tools (2, 3, 4, 6)	6. Representation
	Collaboration (3)			Content accessing tools (1, 5)	7. Administration

[a]Corresponds to an affordance listed in the summary (final column)

computer. A variety of apps available for mobile devices support delivery and access to resources such as e-books, multimedia material and video content, as for example, iBooks, Kindle, YouTube, Perfect Reader, iTunes and iTunesU.

- *Connectivity tool* Mobile technology empowers students to connect to each other, facilitators and experts in the field, exchange ideas and files, socially construct and negotiate meanings, manage activities and negotiate roles in their projects, etc. Connection might be established synchronously and asynchronously over mobile telephony and wireless networks that support voice and multimedia data transmission. These include tools that support communication and social networking, such as for example apps as Facebook, Skype, Google Hangouts, WhatsApp, WeChat, Viber, FaceTime, Facebook and MyPad.
- *Collaboration tool* This affordances enables student to co-design artefacts that demonstrate their learning, collaborate on projects a problem-based task, and share roles and responsibilities. Also, these include tools that allow connectivity to the Cloud, network drives and a computer and co-development of resources. Examples of apps include Air Shawing, FileBrowser, Dropbox, ZumoDrive, Air Drive, AirDisk. Goodle Drive and Office2HD.
- *Capture tool* Mobile technology is equipped with capture capabilities that include capture of video, audio and still photographs. Students might, for example, photograph and videotape machines and people during their industry visits, or photograph diagrams from a book or catalogue (e.g. by using apps such as Genius Scan, Cam Scaner, Dragon, ProCapture or Movie Pro). The capture affordance also includes audio capture (e.g. Smart Voice Recorder App). For example, students might interview experts and capture their own audio notes, or capture characteristic sounds of a faulty engine. There is a possibility for specially designed extensions and consoles to be attached to a mobile device and used to capture, store and process other kinds of data such as, for example, recording global positioning of certain air pollution sources.
- *Analytical tool* A mobile device might be used as an analytical tool to aid students' tasks. For example, these might include standard, scientific and graphic calculators such as Algeo Graphing Calculator App, or specially designed analytical tools created by teachers and designers to allow students to analyse certain data.
- *Representation tool* Mobile technology might be used by students and teachers to create representations which demonstrate their thinking and knowledge. These might be, for example, mind maps, captured and edited images, audio and videos. Apps such as iMovie, HansOn, Bamboo Paper, Penultimate, AudioNote, Draw Free, iPocketDraw. Blogsy and Wordpress enable content creating and editing via mobile devices directly to blogs and websites.
- *Administration* These include mobile tools that support classroom teaching, such as those that support connection to a projector, mark-book, presentation tools and classroom management tools. Examples of apps used are Moodle, Clicker School, TeacherPal, Prezi Viewer, Slides Shark, LanSchool Teacher. A variety of productivity apps can support a spectrum of administrative