Methodological Challenges When Exploring Digital Learning Spaces in Education

Greta Björk Gudmundsdottir and Kristin Beate Vasbø (Eds.)

Over the last decade, the practices by which scholarly knowledge is produced – both within and across disciplines – have been substantially influenced by the appearance of digital information resources, communication networks and technology enhanced research tools. Viewed from a methodological perspective, the rich ICT-based environment in educational settings influences research methods, ethics and the general conduct of research.

Methodological Challenges When Exploring Digital Learning Spaces in Education represents a collection of work of established academics as well as emerging early career researchers all of whom focus on various methodological challenges. From numerous perspectives, the chapters in this volume deal with three particularly demanding challenges for educational research in digital learning contexts. The first challenge concerns how research manages to explore networked learning within a multi-faceted ICT environment. What kind of research designs and forms of data collection are able to grasp this complexity of multiple learning taking place within these contexts? The second challenge deals with how researchers experience the research context and interact with various actors within these settings. How to capture and understand interaction between contexts and across different dimensions of contexts in time and space? And finally, the third challenge is about exploring how children make meaning across physical places and virtual spaces. All together, these challenges are questioning the traditional research methods that we use and are familiar with.

This volume is devoted to stimulating debate about the various methodological challenges facing the researcher in the digital sphere of educational research, and furthermore, exploring what kind of new methodological approaches these challenges impose.

It is aimed at students, researchers and academics within education and those working with learning across disciplines and contexts interested in methodological issues.

Greta Björk Gudmundsdottir lives and works in Oslo, where she is a Researcher at the Norwegian Centre for ICT in Education. Kristin Beate Vasbø also works and lives in Oslo, where she is an Associate Professor at the Department of Teacher Education and School Research, University of Oslo.
Methodological Challenges When Exploring Digital Learning Spaces in Education
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Methodological Challenges
When Exploring Digital
Learning Spaces in Education

Edited by

Greta Björk Gudmundsdottir
The Norwegian Centre for ICT in Education
Oslo, Norway

and

Kristin Beate Vasbø
Department of Teacher Education and School Research
University of Oslo, Norway

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We hope that this volume will be useful and valuable for you as a researcher, graduate student or as a person particularly interested in methodological issues and ICT in various learning spaces.
INTRODUCTION

In a variety of educational contexts today, educators, policy-makers and researchers are turning to ICT-based practices to design learning materials, to structure educational methods, to enhance learning outcomes and experiences, and to develop new approaches in supporting teaching and learning (Athanassios, 2012; Laurillard, 2012; Price, Jewitt, & Brown, 2013a; Punie & Ala-Mutka, 2007). Empowered by technology, students and teachers are turning established teaching models on their heads by “flipping the classroom”, while new skills and demands from the work environment are redefining the emphasis within educational institutions. Moreover, digital media is perceived as a catalyst for new forms of knowledge production by facilitating a variety of opportunities to share content and resources (Drotner, 2013; Sefton-Green, 2013; Leander, Phillips, & Taylor, 2010).

Due to their access to the Internet and a variety of low-cost digital authoring tools, young people today have a broader social and technological repertoire to engage in self-authoring and digital media production (Ito et al., 2013; Ito, 2009). A person with a smartphone has instantaneous access to millions of articles, books, essays, academic research, lectures and courses on every imaginable subject. This development has broken down the barriers that used to exist between knowledge and schools and libraries that were the gatekeepers of knowledge. Young people live in an interactive culture characterized by unlimited access to information and content – anytime, anywhere. Digital media and networks have become a “taken for granted” part of our everyday lives, and thus, provide alternative approaches to how we engage in learning, communication and creative expression (Erstad, 2012; Furlong & Davies, 2012; Miller & Horst, 2012; Ito et al., 2010; Buckingham, 2008; Gee, 2004; Leander et al., 2010). The point of departure of this volume is the question of how we can approach and develop our research methodology in educational research in order to cope with the new digital environment we are facing.

Over the last decade, the practices by which scholarly knowledge is produced – both within and across disciplines – have been substantially influenced by the appearance of digital information resources, communication networks and technology enhanced research tools. Viewed from a methodological perspective, the rich ICT-based environment in educational settings influences research methods, ethics and the general conduct of research. Digital videos and multimedia
make it possible to capture and share much richer records of human action and context, enabling a flexible analysis not only of static artifacts and talk, but also a spectrum of symbolic and physical interactions, including gestures, movements in space and changes over time. The possibilities within these new forms of data are numerous, but at the same time the digitisation of data and other technological developments create new methodological challenges. Although there are rapid shifts in technical development and the types of devices, networks and practices that people engage in, the theoretical and methodological approaches to the pedagogical use of digital technology are developing at a much slower pace (Price, Jewitt, & Brown, 2013b). When we conduct research on current learning practices as they unfold, across and between online and offline contexts, both in an empirically and a methodological sense, our research skills, tools and strategies are put to the test.

This volume is devoted to stimulating debate about the various methodological challenges facing the researcher in the digital sphere of educational research, and furthermore, exploring what kind of new methodological approaches these challenges impose. From various perspectives, the chapters deal with three particularly demanding challenges for educational research in digital learning contexts. The first challenge concerns how research manages to explore networked learning within a multi-faceted ICT environment. What kind of research designs and forms of data collection are able to grasp this complexity of multiple learning taking place within these contexts? The second challenge deals with how researchers experience the research context and interact with various actors within these settings. How to capture and understand interaction between contexts and across different dimensions of contexts in time and space? And finally, the third challenge is about exploring how children make meaning across physical places and virtual spaces. How can researchers manage to analyse processes of meaning making, as they play out simultaneously both online and offline? How to capture learning taking place between contexts? All together, these challenges are questioning the traditional focus on physical places in educational research as the main site for research (Leander et al., 2010). Furthermore, they are questioning the traditional research methods that we use and are familiar with.

New Perspectives on Learning and Space

Over the past 20 years, interest in spatial aspects of human life and social relations has become widespread in a variety of academic disciplines including education (Leander et al., 2010). Perspectives of what the notion of space entails have varied across different authors (Savin-Baden & Howell Major, 2010), and a broad variety of discussions concerning space have become more evident in educational research, challenging established frameworks, theories and practices (Kalervo, 2011). The term “spatial turn” was introduced by the human geographer Edward Soja (1996) who argued for real and imagined spaces to be brought together. On account of Soja’s contribution, among others, space is now acknowledged across the disciplines as a formidable force that shapes human actions. Whereas space was
previously thought of as empty, available and waiting to be filled up, recent theories have revealed that space is a product and process of socially dynamic relations that shape our lives in various ways (Sheehy & Leander, 2004; Pink, 2012).

Space and spatiality are seen as active and formative processes developing over time. The new idea of spatiality of human life separates places from their location, and place is understood in terms of movement and relationships. Furthermore, Moje (2004) claims that material spaces and places shape and reflect our identity and literacy practices. Historically, the field of learning has had a top-down approach, but this is being turned on its head. According to Leander et al. (2010), there is an emergent agenda in educational research for studying students’ learning across space and time in an interdisciplinary way. In this volume, we are inspired by this perspective, and the contributors originate from a wide range of subdivisions within educational research using various methodological approaches. By challenging the perception of the “classroom as a container” for learning, which is a traditional understanding within educational research, Leander et al. introduce an alternative perspective opening up the classroom, by introducing the expression “a node in a network” as a metaphor for the new classroom. The role of new technologies is to support the alternative discourse provided by Leander et al. focusing on themes like learning in place, learning trajectories, learning networks, learning geographies and mobility. Following this line of thinking, digital media serve to further disperse and transform arenas of learning because they are not bound to specific localities, spaces or times of use. The new dynamic perspective of space also strongly affects how we conduct research on learning (Leander et al., 2010; Sheehy & Leander, 2004; Savin-Baden & Howell Major, 2010). Once the concepts and phenomena we want to study are fluid and changing, our research focus and tools need to become unsettled and capable of moving between and across multiple spaces. The chapters in this volume present different angles problematizing how we can capture, explore and understand how learning and meaning making take place across different dimensions of contexts in time and space.

The Multi-Sited Context of Research

Digital technology has been applied, adapted and integrated in existing approaches and established qualitative research methodologies. However, researchers are faced with challenges about what it means to be a qualitative researcher in new immersive learning spaces and how qualitative research plays out within a number of environmental and cultural variables (Savin-Baden & Howell Major, 2010). The development and use of new technology in learning environments, in which education is delivered and supported through ICT, compel researchers to face a number of challenges concerning the exploration and how to make new spaces of learning transparent and accessible for research.

In order to capture interaction and learning taking place across the different dimensions of context in time and space, Drotner (2013) emphasizes the need for
“processual methodologies”. In a similar manner, Pink (2012) uses the concept of “the multi-sensory Internet”. According to Drotner, online and offline participant observation, video recording, and participatory design – among others – are good examples of processual methodologies already taking place in qualitative research within media studies and education studies. Educational ethnography is a subfield in education research, which has its roots in anthropology and microsociology. From the late 1960s, researchers within this field were mostly studying class and gender in school. However, from the 1990s, the research interest began to widen and became more oriented towards out of school activities – vocational training, learning in community centres, in sport clubs, museums and as part of the entire life course (Drotner, 2013). New perspectives on learning challenge the traditional focus in ethnography on bounded physical places as the centre of interest (Leander et al., 2010). According to Drotner, digital forms of learning change the dilemmas for the researcher utilizing processual methodologies when it comes to defining the research subject or research object, and it changes the relation between the researcher and the research person. In order to understand and capture learning in transaction, Drotner claims it is time to develop multi-sited research designs and new creative forms of data collection. Furthermore, the new blend of physical places and virtual spaces of meaning making in these learning processes demands a multidimensional way of examining and analysing these processes in situ, when they play out synchronously online and offline (Drotner, 2013). Current research taking place across a range of times and sites underscores the need to develop new methodological approaches and forms of analysis.

OUTLINE OF THE BOOK

This volume presents researchers who use a wide variety of perspectives and qualitative methods to explore ICT in a number of different learning contexts. The following chapters can be categorized into three main themes: (1) challenges when exploring networked learning and virtual environments; (2) challenges for researcher interaction in various learning sites; and (3) challenges when exploring children’s meaning making in digital contexts. The final chapter draws on the former chapters, views the way ahead and suggests some future approaches important for research and methodological considerations when researching learning contexts of the future.

Part I: Challenges When Exploring Networked Learning and Virtual Environments

The three chapters in the first section of this volume discuss challenges when investigating learning across various virtual environments and networked contexts. In chapter two, Murphy, Castillo, Zahra and Wagner explore how learning experiences that are mediated by mobile technologies (mLearning) expand opportunities to assist and support learning and expand the frontier for educational initiatives from different parts of the world. Mobile technologies may allow users to select when, where and how their learning activities occur. Providing innovative
opportunities for highly individualized learning pushes the boundaries of traditional educational tools, which were typically confined by content, location and functionality. The authors claim it is of critical importance to define new ways for understanding how learning occurs with mobile technologies and to improve methodological approaches for analysing learning outcomes across multiple online and offline contexts. By suggesting research designs sensitive to the ways in which mobile applications are used in and across distinct settings, Murphy and her colleagues provide a detailed characterization of core elements that contribute to an mLearning design solution and the particular techniques used to promote behavioural change and learning.

In chapter three, Stornaiuolo and Hall address the dual challenge of investigating how ICTs are changing the face of education while also trying to mediate the use of these digital technologies in the research process itself. The authors illustrate how challenges of mobility and interconnectedness in networked communicative contexts are manifested in one of their projects as resonance, the intertextual echoing of ideas across spaces, people and texts. To illustrate the concept, they trace one example of resonance across the data by following how conversations around sexuality emerged across the networked community and how this emergence was crystallized in participants’ semiotic activity. Stornaiuolo and Hall discuss the persistent challenges in addressing issues of resonance and, indeed, in capturing and representing the complexity of participants’ learning and engagement across spaces. They claim that there is a need to weave multiple methodologies together in order to continue expanding researchers’ methodological toolkits and enable them to work synergistically across research methodologies. Such an effort across interdisciplinary and technological frontiers is necessary in order to account for the emergent dimensions of meaning making in networked contexts.

In chapter four, Burkle and Magee discuss methodological challenges in designing educational research projects on videogames and 3D online virtual reality environments. The authors explore how research possibilities and challenges are emerging because digital environments and virtual reality are transforming the way learners and instructors interact with each other in and across contexts. Using data from two parallel research projects, the chapter analyses the research challenges of exploring students’ self-identity, problem solving, learning motivations and value construction when interacting with each other for learning in a virtual environment. The authors suggest a practical and more straight-forward research approach, such as the think aloud approach that has been used when researchers examine the thought processes of users engaged in technology-mediated environments. Burkle and Magee claim that such an open methodological approach is capable of examining learning in videogames and virtual realities by, for example, letting the research process be guided by questions articulated by the research persons.
Part II: Challenges for Researcher Interaction in Various Learning Sites

The two chapters in the second section of the book discuss challenges and possibilities in the relationship between the researcher and the researched person in digital learning environments. In chapter five, Donovan discusses how participatory research and design with youth co-researchers presents methodological challenges that, when they are met, help build capacities for critiquing and engaging private modes of knowledge production. Donovan claims that the productive and entertaining promises of proprietary communication, education and play media in post-industrial societies have led to the widespread adoption among youth whose daily activities now generate troves of data that are mined for profit. As young people learn to text, email, browse and search within such environments, their identity configurations link up with informational modes of capitalist production. In his chapter, Donovan presents a methodological approach aimed at involving young people in the collaborative process of research and reflection through the co-design of an open source social network.

In chapter six, Hatlevik and Egeberg present and discuss experiences from a research project where researchers were asked to follow the implementation of interactive whiteboards in a school. They discuss the relationship between the researcher and the research person from another angle than the previous chapter, particularly problematizing how researchers can manage both the role of the researcher and the educational expert when the researchers and the teachers have different goals and expectations of the outcome of the researchers’ participation in the project. From a research perspective, a fundamental question when technology is introduced in schools is how to gather and analyse data that can shed light on issues related to the implementation and use of technology in teaching. A video clip might be used as a tool for researchers achieving consensus when concluding on empirical findings. However, a teacher might view the clip with another intention, for example, to improve his or her practice. Hatlevik and Egeberg suggest constructing research groups that possess the necessary knowledge and experience to achieve the goals of the study and at the same time meet the expectations of the research subjects.

Part III: Challenges When Exploring Children’s Meaning Making in Digital Contexts

The two chapters in the last section of the book discuss challenges when exploring and investigating how young people are making meaning across physical places and virtual spaces. In chapter seven, Pribišev Beleslin addresses challenges when combining different methodological approaches in order to investigate how small children make meaning when they use ICT. In order to discover the richness of young children’s stories about digital culture, Pribišev Beleslin makes use of a mosaic approach inspired by the “pedagogy of listening”, which is based on relations, encounters and dialogues between co-constructors of meaning making. Pribišev Beleslin presents a methodological approach suggesting researchers listen
carefully to the children and access their perspectives and early experiences by combining a mosaic of participatory methods. Such an approach represents a source of many pieces in a puzzle that creates an image of children’s worlds, both individual and collective.

In chapter eight, Davidsen and Vanderlinde similarly apply the children’s perspective and highlight the importance – as well as the lack – of doing so in studies of ICT. The authors discuss the challenges and potentials of using micro multimodal video analysis of children’s collaborative learning activities supported by touch-screen technology. Their research project integrating touch-screens in two primary school classrooms explores children between the age of eight and nine years. As a methodological approach, Davidsen and Vanderlinde suggest making use of micro multimodal video analysis in order to provide thick descriptions of how young children experience and interact with ICT in a specific context, focusing on how they engage in collaboration through language, gestures and digital learning materials. Most importantly, their contributions together with Pribišev Beleslin’s chapter show how to conduct research from the children’s perspective, and how such a perspective can enrich both teachers’ pedagogical thinking as well as qualify our scientific understanding of how children are acting and making meaning in a digital environment.

FINAL CONSIDERATIONS

The ninth and concluding chapter in this volume continues the discussion from the introductory chapter regarding new perspectives and understanding of space as a fluid concept and the challenges investigating learning that takes place across space over time. In this chapter, Gilje and Erstad discuss transitions and trajectories in young peoples’ learning lives and in particular the methodological challenges of studying learning across contexts. Technological developments create changes in the social practices we are studying, and provide us with new tools for doing empirical work. Gilje and Erstad’s concerns are how we can research the learning lives of young adults. Methodologically, it is complex and difficult to follow learners across and between sites or conceptually, tracing, translating and reconfiguring understanding across contexts. Drawing on two large studies (Learning Lives and KnowMo), the authors suggest how research on trajectories of participation and transitions in young adults’ learning lives can take place across contexts. Based on experiences from these projects, the authors raise some issues and challenges about using digital media to collect and analysed data, and ways of involving study subjects as co-researchers.

The overall aim of this volume is to explore some key challenges for educational research in digital contexts. The result is a collection of contributions that do not focus on a particular aspect of qualitative methods, but rather a volume that reflects on both the variety of accessible research methods and possibilities for developing new methods designed to capture new understandings of learning taking place across and between online and offline spaces. The various contributions in this volume explore the three main challenges we claim are raised
by the growth of ICT in educational research today. These challenges are (1) how research manages to explore networked learning within a multi-faceted ICT environment; (2) how researchers experience the research context and interact with various actors within these settings; and (3) how children make meaning across physical places and virtual spaces. Together, these nine chapters problematize how we observe and describe emerging forms of learning in current educational research when ICT is both the medium and the object of research.

REFERENCES

METHODOLOGICAL CHALLENGES AND NEW LEARNING SITES


Kristin Beate Vasbø
Department of Teacher Education and School Research
University of Oslo
Norway

Greta Björk Gudmundsdottir
The Norwegian Centre for ICT in Education
Norway
PART I

CHALLENGES WHEN EXPLORING NETWORKED LEARNING AND VIRTUAL ENVIRONMENTS
2. MOBILE LEARNING DESIGN SOLUTIONS

Innovations in Learning through the Use of Mobiles across Contexts

INTRODUCTION

As the world prepares for the next generation of United Nations development goals, two critical priorities will be needed to build a sustainable global community and economy: advancing educational quality through improved learning experiences and reducing inequities in educational opportunities. Addressing these priorities within diverse contexts across the world presents a formidable challenge that has not yet been achieved despite major investments in school infrastructure, teacher training and the procurement of learning materials (Patrinos & Psacharopoulos, 2011). At the same time, recent studies of early grade reading have found that many children are unable to read a single word in the language of instruction, even after several years of schooling (Gove & Cvelich, 2010). Further, variations in school quality have been found to have a greater influence on educational outcomes and economic growth than the number of years of schooling (Hanushek & Woesman, 2007). As these studies underscore, increased enrolment and years of schooling are not a panacea for the learning failures observed throughout the world. While there is a strong case for the inadequacy and inefficient distribution of current educational funding (UNESCO, 2013a), improved development investments must build upon effective strategies and draw from innovative solutions to boost learning opportunities, in schools as well as out-of-school.

New information and communications technologies (ICTs) offer hope in contexts where past interventions have been unsuccessful and in locations where populations have been marginalized or excluded from social services, schools or learning resources. This is particularly the case with mLearning, or learning experiences that are mediated by mobile technologies (Winters, 2006). MLearning allow users to have the opportunity to engage in learning processes at any time, at any place, and in an individualized manner (Quinn, 2001; Peters, 2007). Mobile technologies include a broad range of portable electronic devices such as: laptop and hand-held computers, tablets, cellular phones, personal media players, among others. By virtue of being portable, increasingly accessible, affordable and ubiquitous (UNESCO, 2013b), mobile devices may provide opportunities for
improved learning experiences across a wide array of contexts including the schools, neighbourhoods and homes with children and adults that have been traditionally marginalized (Muyinda, Lubega, & Lynch, 2010).

The use of mobile technologies as a learning tool has expanded beyond high-income settings, and is now becoming prevalent in low-income contexts in developing countries (Nugroho & Lonsdale, 2010; Hinostroza, Isaacs & Bougroum, 2012; Wagner, 2013). Similarly, mobile technologies have been used in agriculture, banking, health and other sectors throughout the world. While early applications have primarily focused on data collection and information transmission, they have also been used to promote behaviour change aimed at improving economic, physical and social wellbeing (e.g. Fjeldsoe, Marshall, & Miller, 2009; Cole-Lewis, & Kershaw, 2010; Cole & Fernando, 2012; Free et al., 2013).

Apart from the potential to increase access to information and learning activities, mobile technologies can include interactive and multi-functional capabilities that differentiate mLearning from learning processes that typically occur using other types of educational tools. For instance, traditional textbooks may be considered mobile tools in that they often are designed to be portable resources for classroom-based coursework and at-home study. Yet traditional textbooks face several challenges in the context of low-resource settings and developing countries: they are limited to a finite amount of information and educational activities contained within the text, which take substantial amount of time and resources to revise and update; they are often expensive to produce and distribute; they are printed in the languages determined by the government or educational publisher, usually based on political and economic factors; they are prone to damage and destruction; and their ability to serve as an effective learning tool often hinges on the instructor's training and familiarity of the specific text (Glewwe, Hanushek, Humpage, & Ravina, 2011; Lockheed & Hanushek, 1988).

Mobile technologies do not have immunity to these challenges, yet innovative designs can address many of the issues related to content limitations, cost, distribution, language and durability. Furthermore, within one device, mobile technologies can enable information access, communication, social exchange, participation in interactive games, location and geographic navigation services and other functions that are not typical characteristics of a single educational tool. Unlike conventional learning tools designed for specific functions and contexts, mobile technologies may allow users to select when, where and how their learning activities occur, providing innovative opportunities for highly individualized learning (Peters, 2007).

The potential for multi-functional and individualized learning through mLearning applications pushes the boundaries of traditional educational tools, which were typically confined by content, location and functionality. It is therefore of critical importance to define new ways for understanding how learning occurs with mobile technologies and to improve methods for analysing learning outcomes. This requires a careful examination of the various aspects of an mLearning initiative that influences how, where and why applications are used, as well as an
understanding of the human interactions that occur during and after use and the changes in human behaviour and learning that result.

Several scholars have proposed conceptual frameworks for understanding mLearning applications (e.g., Motiwalla, 2007; Park, 2011; Muyinda, Lubega, Lynch, & Van der Weide, 2011), employing various combinations of technological, pedagogical and contextual factors. In formulating a multi-dimensional framework for mLearning, Muyinda and colleagues (2011) provide a useful comparison of several relevant frameworks, highlighting existing research gaps, such as the lack of consideration for device limitations, network conditions, pedagogical approaches, user characteristics, costs, supportive policy frameworks and variations in learning content sources. Despite the recent scholarship in the field of mLearning, each proposed framework falls short in providing clear guidance for mLearning research methodology.

Addressing the need for a versatile mLearning framework to guide research methodology, the present chapter draws from past research and offers a basic conceptual framework that builds from a recent landscape research review of mobile technology for reading (Wagner, 2013). In the proposed framework, key attributes and variables that contribute to the design solution are identified and described. Throughout the following three sections, the term design solution refers to a complex composition of factors that contribute to an mLearning initiative. The first section highlights three key elements that influence an mLearning design: purposes, devices and users; the second section describes the way in which contexts and the user’s environment interacts with mLearning processes; while the third section focuses on the need to identify and evaluate specific learning techniques employed within the mLearning design solution. Throughout, a number of methodological considerations for mLearning research are discussed.

The key components described below contribute to the basic structure of the proposed conceptual framework for mLearning design solutions. This framework can provide guidance for improved research methodology that investigates specific components of mLearning applications, their interactions with other components of the design solution and variations in outcomes and effects as a result of such interactions. Applied to research and evaluation studies, the design solution framework may advance understanding of learning processes through mobile devices, paving the way for improved evidence-based design of future innovations.

A CONCEPTUAL FRAMEWORK FOR mLEARNING:
PURPOSES, DEVICES AND USERS

The complex factors that contribute to the design process of mLearning initiatives have not been adequately understood through existing methodological approaches. In the practical application of any mLearning initiative, the design process is embedded in contextual conditions that include cultural, economic, political and social influences. The dynamic interactions among these factors contribute to the contextual ecosystem of mLearning. Within this ecosystem, three key components form the basic structure of a comprehensive mLearning design and evaluation
strategy: (a) intervention purposes; (b) device specifications; and (c) end-user characteristics (for a more detailed discussion, see Wagner, 2013). Located at the intersection of these three factors, one or more design solutions may emerge to encompass the appropriate content and implementation strategy of an mLearning initiative, as depicted in Figure 1. A brief description of each component highlights key variables that impact the formative processes of mLearning design, which should be considered when developing appropriate research methodologies.

![Diagram](Image)

Figure 1. Design solution at the intersection of devices, end-users and purposes

(a) How Does the “Purpose” of the Intervention Shape Design?

The design of mLearning initiatives often stem from the identification of a problem, gap or need, which may be conceptualized as the intervention purpose. Intervention purposes are sometimes explicitly stated by program designers, while at other times can only be implied from program reports or project websites. As described in Wagner (2013), primary intervention purposes include:

- **Formal learning and instruction**: drawing from structured, instructor-led pedagogical methods that typically form part of an established program of study.
- **Informal learning**: focusing on less structured, user-centred pedagogical methods.
- **Content delivery**: providing users with information, textbooks, curricular resources and reading materials, without explicitly engaging in interactive activities.
- **Training**: supporting professional skill development for adults or facilitators who serve as intermediaries for other learners.
- **Data collection and assessment**: using mobile technologies for monitoring, evaluation and learning assessments.
- **Communication**: providing increased opportunities for social interaction and communication among target users.

Many interventions do not fall exclusively within a single purpose and may combine two or more purposes within a single initiative. Yet in each mLearning
initiative, the clear identification of the purpose provides a roadmap for the selection of research questions and outcome indicators that are essential in the methodological design of an mLearning evaluation. For example, in comparing initiatives designed for similar purposes, field testing, randomized control trials and quasi-experimental studies can be used to investigate differences in learning outcomes and student experiences in mLearning compared to non-mLearning approaches. Observational studies and ethnographic techniques could offer insight into the ways in which learners respond to the use of mLearning for various purposes. Additionally, the analysis of activity logs from mLearning applications can be used to better understand if the design solution achieves the intended purpose, or if users have found various ways to re-purpose an mLearning application.

(b) How Do the Specifications of Particular Devices Shape Design?

Mobile technologies encompass a broad variation of functionality, cost, accessibility and connectivity and these attributes have a direct impact on mLearning design solutions. Commonly used mobile devices include laptops, tablets, portable media players and phones that range from basic voice and text message capability to advanced or smartphones that mimic some of the capabilities of computers or tablets. Interventions that make use of such devices are expanding in high and middle-income countries; yet economic, logistical and practical considerations can often weaken the case for mLearning in low-income countries (GSMA, 2010). Challenges to mLearning sustainability are common in education systems with limited resources, as issues related to device procurement, appropriate technology use, connectivity, device maintenance and repair often threaten the development of viable implementation strategies. Nonetheless, recent funding efforts that promote innovation are encouraging increased experimentation with mobile solutions among organizations (Hinostroza et al., 2012), and may address some of the current challenges of mLearning in developing contexts.

The particular specifications of a device influence the developers’ ability to include interactive activities, audio and video content, or e-books that require large amounts of memory. Similarly, certain devices may be less appropriate for particular environmental, infrastructural or social conditions (e.g., places that may be prone to extremes in temperature or weather, may not have adequate power supply or repair facilities to maintain device operation, or may be sold or stolen). At the same time, an overreliance on device design limits resources for capacity development and maintenance (DeBoer, 2009), and such oversight can ultimately impact the long-term usage and the learning outcomes of an otherwise innovative intervention.

Device specifications, including user interface, procurement costs, connectivity, multi-media functionality, durability, maintenance and repair issues are critical considerations for mLearning research. The analysis of device specifications is a critical step in formative research and process evaluation, as it may be used to
select the most appropriate device for a particular context, which requires field testing, costing studies and the analysis of user interaction with potential devices.

(c) How Do the Characteristics of the End-User Shape Design?

Intervention design strategies must take into serious consideration the specific characteristics of the intended end-user population. These include: age, location, socio-economic status (SES), education and literacy level, language, culture, gender, health profiles and individual learning differences. Further, individuals’ learning dispositions and their different types of knowledge relevant to the mLearning application also influence the design strategy (Mishra & Koehler, 2006). An understanding of the learner’s characteristics and baseline knowledge can inform the design of instructional content and support materials, taking advantage of observed strengths and compensating for weaknesses or knowledge gaps. In this sense, a comprehensive mLearning design should complement end-user characteristics.

In order to respond to end-user characteristics and variations in learning dispositions, teachers and instructional materials need to adapt pedagogical approaches when using mLearning technologies. For example, a study examining Bangladesh Virtual Interactive classrooms (BVIC), the largest distance education project by the Bangladesh Open University, found that significant changes in content and pedagogical approaches were needed to appropriately respond to end-user characteristics and learning dispositions toward the interactive learning management system and SMS-based lessons (Islam, Ashraf, Rahman, & Rahman, 2005; Grönlund & Islam, 2010). Similarly, in a study conducted by Nihuka and Voogt (2011) for the Open University of Tanzania, the role of teachers and their attitudes toward various types of technologies was identified as an important influence on the end-user’s learning experience.

With a comprehensive understanding of the end-user characteristics, learning dispositions and appropriate pedagogy, mLearning applications hold great potential for educational initiatives specifically tailored to distinct populations of learners. For example, mLearning applications in high-income countries suggest that the use of mobile technologies can assist in language and communication development for children with Autism Spectrum Disorder by allowing learners to manipulate and combine graphic representations of words and concepts (Shane et al., 2011). In low and middle income countries, there are several examples of mLearning applications that have been designed to address specific needs of particular demographic groups, such as women, ethno-linguistic minorities, or out of school youth (e.g. Kumar, Reddy, Tewari, Agrawal, & Kam, 2012; Vosloo, Walton, & Deumert, 2009; Zain, Mahmud, & Hassan, 2013).

Despite the great potential to tailor mLearning initiatives to distinct user characteristics for individualized learning experiences, this also raises important concerns that are serious considerations for research methodology. User demographics and trends and patterns in personal usage of mLearning applications, such as the amount of time per day a user interacts with a mobile device, provide
valuable data for the analysis of mLearning applications. Yet research approaches that take advantage of user information from mobile technology require careful consideration of privacy and ethics. Unauthorized disclosures or inappropriate use of personal information and location data could lead to embarrassment, marginalization or threaten rights to privacy and safety. In the absence of established, universal standards for mobile data use and analysis, researchers and practitioners should exert substantial attention to these important ethical issues relevant to mLearning.

MULTIPLE CONTEXTS OF MLEARNING

The key components of mLearning design: purposes, devices and end-users must be analysed through the lens of dynamic, multiple contexts in order to gain a more comprehensive understanding of how these initiatives function in the real world, within and across distinct contexts. For example, learning processes that are prompted through the use of a mobile phone-based language learning application cannot be adequately studied in a controlled classroom or laboratory setting. Instead, research designs must be sensitive to the ways in which mobile applications are used in and across distinct settings. In this sense, mLearning contrasts with conventional learning interventions, whether part of a formal curriculum or an out-of-school educational program, which are often designed to fit within the circumstances and conditions of a particular context. Variations in these conditions can be conceptualized as part of a continuum, ranging from formal to non-formal learning contexts, as illustrated in Figure 2 (see also Wagner, Murphy, & de Korne, 2012).

Figure 2. Multiple contexts of mLearning
Formal and Non-Formal Contexts

The traditional Western classroom typifies the formal learning context and is a model that has been replicated in schools and learning institutions throughout the world. School directors, ministers of education and most international agencies tend to focus resources on improving learning within these formal learning contexts, as they are spaces that are specifically designed for educational purposes and may be monitored and controlled. On the other end of the spectrum are spaces that have not been consciously designed for educational purposes, yet where learning still occurs, which can be described as non-formal contexts. These may include the natural environment, homes, markets and neighbourhoods, among others. After-school education programs, preschools, non-traditional or independent schools, educational drop-in centres and a broad variety of other initiatives fall on varying points along the two ends of the learning contexts spectrum. The approach adopted by many conventional learning initiatives has been to determine a design strategy based on a defined use case that is grounded in a specific context (e.g., Henry, 2001). Classroom-based science experiments, after-school youth literacy programs, desktop computer games to improve math or typing, offer a few examples of learning initiatives designed for specific contexts. Learning applications on mobile devices, in contrast, typically operate in multiple contexts and warrant a distinct approach to design and research methodology (Park, 2011).

Mobiles and Learning Innovations in Multiple Contexts

The ‘m’ in mLearning distinguishes it from other learning media precisely because its applications are mobile and it is difficult to confine use to one particular context. Although some projects may try to restrict the use of an mLearning application to classrooms or after-school settings, one of the unique advantages of mLearning is its ability to adapt and integrate across contexts, as mLearning becomes increasingly ubiquitous (Park, 2011; Shuler, 2009; Peters, 2007). This conceptualization of mLearning encompasses dynamic transitions across time and space, as well as enhanced opportunities for the spontaneous creation of virtual contexts formed through social interaction among learners around a shared conversation or topic of interest (Sharples, Taylor, & Vavoula, 2007). Capturing and describing the influence of the diverse and reciprocal contexts on mLearning activities represents a challenge in the field of educational research.

Furthermore, as technology advances, mobile devices will likely improve their ability to sense and detect contextual cues relevant to the user in a particular time and space to create highly adaptable learning applications, as illustrated by advancements in Context-Aware Mobile Learning (Tan, Liu, & Burkle, 2013). To better understand the complex ways in which learners interact within mobile contexts, traditional methods of observation or self-reported surveys may be used, and the location-tracking and usage-monitoring capacities within mobile devices
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may also be employed to gain a more comprehensive understanding of specific learning activities that occur in various contexts.

MLEARNING TECHNIQUES WITHIN THE DESIGN SOLUTION

The analysis of any mLearning initiative requires a consideration of the intended purpose, the advantages and disadvantages of the selected device or devices, the capabilities and needs of the end-user population, together with an understanding of user interactions across multiple contexts. At the same time, mode of delivery (e.g., synchronous or asynchronous, group or individual use, etc.), the intensity and duration of the intervention, the characteristics of those involved in the design and implementation (including the level of participation of end-users in the process), and the pedagogical approach and use of specific learning techniques all have a direct influence on the overall design solution. Expanding on the conceptual framework presented earlier, Figure 3 includes some of the key factors within each component, including the important considerations that influence the design solution.

Figure 3. Detailed description of design solution components
The highlighted learning techniques represent a critical piece of the design solution with a direct bearing on our understanding of the interaction between human learning and mobile technology. Learning techniques are specific applications of theory-grounded strategies used to prompt the acquisition of new knowledge, skills and behaviour change. The concept of learning technique analysis borrows from recent work in the field of behaviour change, public health and more recently mHealth (Abraham & Michie, 2008; Free et al., 2013). This approach recognizes the need for methodological designs that not only measure longer-term outcomes (e.g., educational gains), but that also investigate various techniques that may be used to promote learning, social interaction and behaviour change. The clear identification and analysis of specific learning techniques allows for an improved understanding of effective strategies that can be used to inform future mLearning initiatives.

In the field of public health, Abraham and Michie (2008) proposed the need for a clearly defined taxonomy of behaviour change techniques based on prominent learning and behaviour change theories in public health interventions (cf. Glanz, Rimer, & Viswanath, 2008). Drawing from this work, the analysis of mLearning techniques can provide important insights regarding the ways in which particular interventions function. Table 1 provides some examples of mLearning techniques, how each technique may be applied in an mLearning initiative, and relevant research topics that may be designed to analyse and measure discrete aspects of each mLearning technique. Such research topics could be incorporated into the methodological design through observational studies, analysis of activity logs, randomized control trials and quasi-experimental studies.

Descriptions of mLearning initiatives often highlight the intervention purposes, but provide scant descriptions of the actual mechanisms employed to promote learning. This oversight hampers the advancement of methodological approaches to analyse, evaluate and compare distinct mLearning initiatives. The mLearning techniques listed in Table 1 provide a small sample of a broad range of options that could be considered when designing a learning strategy. Further research would offer increased understanding about the varieties of learning techniques employed by each innovation. Targeted research would also provide an improved understanding of how various techniques function across a range of contexts, as the cultural, economic and social climate may play an important role in determining the most effective technique for a particular context. For example, are social modelling techniques more effective in socially oriented societies compared to individualistic societies? Are certain techniques more effective for particular age groups? What are the device characteristics and implementation strategies required for various techniques? By identifying which techniques or combination of techniques are at play in a mobile application, researchers may better understand effective approaches to promote increased learning and achieve educational goals.
Table 1. Useful mLearning techniques drawn from Abraham and Michie’s (2008) taxonomy of behaviour change for public health

<table>
<thead>
<tr>
<th>mLearning Techniques</th>
<th>Example Uses of mLearning Techniques</th>
<th>Examples of Relevant Research Topics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strength and Barrier Identification</td>
<td>Prompt identification of knowledge areas or skills that serve as personal strengths, as well as skills and abilities that could be improved</td>
<td>Self-awareness of knowledge areas or skills that serve as personal assets as well as learning “barriers”</td>
</tr>
<tr>
<td>Contingent rewards</td>
<td>Provide positive reinforcement for completed tasks; reward values may increase with task difficulty</td>
<td>User response and changes in motivation resulting from positive reinforcement and rewards</td>
</tr>
<tr>
<td>Encouragement</td>
<td>Provide motivational support without rewards, and that is not contingent upon the completion of tasks</td>
<td>User response and changes in motivation resulting from encouragement and support</td>
</tr>
<tr>
<td>Graded tasks</td>
<td>Introduce simple tasks, increase difficulty, provide hints or help until task is performed. Continue to increase difficulty until learning objective is met</td>
<td>Analysis of task performance, persistence towards a defined learning objective</td>
</tr>
<tr>
<td>Performance feedback</td>
<td>Provide immediate or short-term feedback on performance of a specific task or learning objective, to compare with set standards or goals</td>
<td>User response to feedback, analysis of task performance</td>
</tr>
<tr>
<td>Self-established goal setting</td>
<td>Prompt intention formation or goal setting with specific targets</td>
<td>User response to feedback, analysis of task performance</td>
</tr>
<tr>
<td>Social comparison</td>
<td>Provide information about peers’ behaviours or others’ attitude toward the behaviour</td>
<td>User response to others’ behaviours and/or knowledge of the others’ attitudes about behaviours</td>
</tr>
<tr>
<td>Social modelling</td>
<td>Allow users to observe others performing or demonstrating task and completing set goal; encourage imitation of task</td>
<td>Task performance before and after observations of social modelling</td>
</tr>
</tbody>
</table>

CONCLUSION

The expansion of mobile technology for learning presents new opportunities to address persistent challenges to achieving improved and equitable learning experiences – even in some of the most marginalized contexts of developing countries. At the same time, a major impediment to progress in this field has been
the lack of clarity surrounding the notion of mLearning. The conceptual framework proposed in this chapter attempts to provide a detailed characterization of the key components that contribute to an mLearning design solution and the particular techniques used to promote behavioural change and learning. The application of this framework can provide a more comprehensive understanding of an intervention’s impact as well as promote the appropriate adoption, adaptation and replication of future mLearning innovations.

Several important considerations are central in the development of an appropriate research or evaluation strategy. Among the most pertinent of these considerations include issues of privacy and ethics in the use of personal information, and the need to support the integration of local expertise in research design and implementation. The possibility of tracking learning activities across various contexts could provide important insights not only for mLearning, but also for education and learning initiatives more broadly. With an improved understanding of how and where students engage in mLearning, educators, parents, caregivers, policymakers and others may effectively identify key opportunities for new interventions to augment positive learning behaviours. At the same time, mLearning methodologies that make use of user data must also be sensitive to ethical responsibilities to protect personal information and privacy, particularly in contexts where protective legal structures and policies are absent or weak.

With a large majority of the world’s population living in low and middle-income countries, greater efforts should also be focused on ways in which mLearning may operate in places where the cultural, economic, environmental and social climate differs from highly industrialized nations. An understanding of these ecological factors requires insights and expertise from local researchers, community members and the targeted end-users. MLearning can provide an extended platform for research, monitoring and continuous innovation by local researchers, as they can use real-time data to better understand users behaviour and experiences with devices. Also, research designs should be sensitive to populations that are often excluded from mainstream education programs in low-resource settings, such as women, ethnic and linguistic minorities and learners with physical and cognitive disabilities. Often subjects of marginalization and exclusion, these populations may have the greatest gains from new applications of mLearning initiatives that may be adapted to particular learning needs across a range of contexts.

Looking forward, mLearning specialists will continue to explore new ways to harness the multi-functional capabilities of mobile technologies. Concomitant methodological approaches will be needed to better understand how learning occurs with mobile devices in and across multiple contexts. There is little doubt that future mLearning designs will require new thinking that expands, extends and interconnects the traditional boundaries of education, learning and technology.
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Katie M. Murphy
Graduate School of Education
University of Pennsylvania
USA

Nathan M. Castillo
Graduate School of Education
University of Pennsylvania
USA

Fatima T. Zahra
Graduate School of Education
University of Pennsylvania
USA

Daniel A. Wagner
Graduate School of Education
University of Pennsylvania
USA