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First edition

Information technology for learning, education and training — Nomadicity and mobile technologies

Technologies de l'information pour l'apprentissage, l'éducation et la formation — Nomadisme et technologies mobiles

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Foreword

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This document was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 36, *Information technology for learning, education and training*.

This first edition cancels and replaces ISO/IEC TS 29140-1:2011 and ISO/IEC TS 29140-2:2011, which have been technically revised.

The main changes compared to the previous edition are as follows:

— ISO/IEC TS 29140-1:2011 and ISO/IEC TS 29140-2:2011 have been combined as a single document.

— New terms and definitions and use cases have been added.

— The referencing explanatory report has been removed.

— Minor editorial changes have been made throughout the document.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document provides guidance on the use of a learner information model for mobile technology in learning, education and training (mobile learning). It can be used as a reference by software developers, implementers, instructional designers, teachers, trainers, automated systems, and learning management systems.

Since ISO/IEC TS 29140-1:2011 and ISO/IEC TS 29140-2:2011 were published, there have been many technological innovations and increasing use of mobile technology in learning, education and training as indicated in many of the review and meta-analysis studies on mobile learning.[4],[6],[8],[9],[14],[17] The growth in active mobile-broadband subscriptions has increased significantly, with penetration rates increasing worldwide from 4,0 subscriptions per 100 inhabitants in 2007 to 69,3 in 2018.[13] The number of active mobile-broadband subscriptions have increased from 268 million in 2007 to 5,3 billion in 2018.[13] In addition, almost the entire world population, or 96 %, now lives within reach of a mobile cellular network. Furthermore, 90 % of the global population can access the internet through a 3G or higher speed network.[13] This is placing a sense of urgency to revise the standards for the use of mobile technology in learning, education and training.

At the same time, the technology and the application of the technology is changing at a fast rate. For example, 3D glasses are being used for virtual reality, augmented reality and mixed reality; and voice input and output are being used for language training. In 2017, an analysis of 233 refereed articles from 2011 to 2015 from peer-reviewed journals was carried out based on the research themes, methods, settings and technologies in the research.[14] The results were compared to three previous literature review-based research studies that were conducted between 2001 and 2010 to identify similarities and differences. The findings were that: (1) mobile learning in higher education is a growing field as evidenced by the increasing variety of research topics, methods, and researchers; (2) the most common research topic continues to be about enabling m-learning applications and systems; and (3) mobile phones continue to be the most widely used devices in mobile learning studies, however, more and more studies work across different devices, rather than focusing on specific devices.

As schools, governments, organizations and businesses around the world design information for access by mobile devices, there is increased need to set standards for how information should be designed for delivery on mobile technologies to support learning, education and training. This increased need is necessitated by demand for learning and training materials that can be shared easily between organizations and learners and made available to those in any geographical location. Mobile learning has the potential to provide learners with enhanced access to information and learning materials and guidance and support from anywhere rather than from a specific geographical location at a certain time. When mobile learning is implemented thoughtfully and well, it has the potential to increase efficiency and productivity for learning, education and training within different sectors (e.g. public, private, voluntary).

A meta-analysis and research synthesis of the effects of integrated mobile devices in teaching and learning analysed 110 experimental and quasi-experimental peer-reviewed journal articles published from 1993 to 2013.[17] Results revealed that the overall effect of using mobile devices in education is better than when using desktop computers or not using mobile devices as an intervention, with a moderate effect size of 0,523. An analysis of 144 refereed journal articles from the top six major educational technology-based learning journals listed in the Social Science Citation Index database found that most mobile learning studies reported positive outcomes and the smartphone is the most widely used device for mobile learning.[6] Mobile learning has the potential to provide learners with new opportunities to connect with other learners, to interact with teachers and trainers, and to co-create collaborative learning environments. This is a critical issue for learners who live in remote locations lacking wired connections.[5] Learners living in these remote locations can use mobile technologies with wireless capabilities to connect with others in different locations. As a result, remote learners might feel less isolated, which could result in more learners completing their learning, education or training activities using mobile technologies. An analysis of 90 articles that studied the qualities of mobile learning reported that the educational properties of mobile collaborative learning include: supporting ubiquitous learning, allowing more interpersonal social interaction, facilitating context-based learning, cultivating self-regulated learning and self-reflection, and fostering cross-

cultural interaction.[9] The conclusion was that, compared to internet-based learning, mobile-based collaborative learning is better able to serve as cognitive, metacognitive and epistemological tools for students' understanding and concept transformation.

There are a number of research teams in organizations and communities who are working on mobile learning. Many research studies and projects have been completed on the use of mobile technology in education and training. Additionally, work is already in progress in various countries around the world on related topics such as, learning in different contexts, learning while on the move, and the use of handheld computers in learning. This is evident by the nine use cases that are included in Annexes A through I. In addition, work is in progress on some of these issues at the W3C and the ITU-T.

As this work progresses, it is essential to prepare the groundwork to ensure that the design, development, implementation and evaluation of mobile learning within learning, education and training environments will take place in a manner that is seamless, flexible and integrated. In short, mobile technology needs to be seamlessly integrated into teaching and learning activities that are supported by information and communication technology (ICT) in general. A review of models and frameworks for designing mobile learning experiences described different learning strategies for using mobile technologies in learning.[11] These include: (1) context-aware learning where learners can learn in their own context using wireless connection, global positioning systems, satellite connection and mobile apps; (2) seamless and ubiquitous learning on the go and learning from anywhere because of the portability of mobile technologies – learning strategy is important for the nomadic learners who move from one location to the next; (3) game-based learning where learners are presented with different scenarios and challenges during the learning process; (4) mobile computer-supported collaborated learning where students use mobile technologies to interact to complete learning activities in groups.

In the past, use of mobile technologies, because of their small size and portability, have been beneficial to nomads; however, the current mobile technologies are more powerful and they are being used in different locations and different contexts for learning. For example, mobile technologies can be used in a classroom to teach school-age children about disease transmission patterns; in medical education to support students learning about bedside clinical practice; in an industry to train employees how to maintain a piece of equipment; in a museum to give students a virtual presentation of a historical event; in a college to give students a virtual tour of an archaeological site, and so on. The potential use of mobile technology is unlimited, its use will depend on the creativity of the instructional designer, teacher or trainer. An analysis of 113 research studies on mobile learning in pre-kindergarten to Grade 12 levels found that 62 % of the studies reported positive outcomes, meaning that the majority of studies found that the use of mobile devices in a learning activity resulted in increased student learning.[8] It also reported that the majority of the studies (50 %) took place in formal educational contexts while a setting composed of both formal and informal settings accounted for 27 % of the educational contexts, and the remaining 23 % of the studies took place in informal settings.

Information technology for learning, education and training — Nomadicity and mobile technologies

1 Scope

This document provides a learner information model specific to mobile learning to enable learning, education and training environments to reflect the specific needs of mobile participants.

This document provides:

— definitions of mobile technology and mobile learning appropriate for all sectors in learning, education and training;

— a description of the learner information model for mobile learning;

— specific learner information that supports learners engaged in mobile learning activities in learning, education and training environments.

— a description of the learner interaction model with mobile systems;

— consideration of learner interactions specific to nomadic learners who move from place to place;

— initial guidance regarding the issue of privacy.

This document does not include:

— in-depth technical review of issues related to adaptability to culture, language and individual needs;

— broad or in-depth technical interoperability issues of mobile computing domains;

— security, authentication or accessibility considerations;

— in-depth details regarding privacy;

— detailed information regarding complementary work within other organizations that might be relevant.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
adaptive design
creation of multiple versions of a web page to better fit the learner's device rather than a single static page that looks the same on all devices

3.2
artificial intelligence
AI
branch of computer science devoted to developing data processing systems that perform functions normally associated with human intelligence, such as reasoning, learning and self-improvement

[SOURCE: ISO/IEC/IEEE 24765:2017, 3.234]

3.3
augmented reality
virtual objects superimposed upon or composited with the real world

Note 1 to entry: Virtual and real-world objects co-exist in augmented reality systems.

3.4
learning
acquisition of knowledge, skills or attitudes

[SOURCE: ISO/IEC 2382-36:2019, 3.1.1]

3.5
learner information
recorded information associated with learners and used by learning technology systems

Note 1 to entry: Learner information may be created, stored, retrieved, used, etc. by learning technology systems, individuals (teachers, trainers, learners, etc.), and other entities.

[SOURCE: ISO/IEC 2382-36:2019, 3.7.1]

3.6
learning technology system
LTS
information technology system used in the delivery and management of learning

3.7
mixed reality
display continuum in which both real and virtual images are combined in some way and in some proportion

Note 1 to entry: Augmented reality (AR) and virtual reality (VR) are considered to be on the mixed reality continuum.

3.8
mobile learning
m-learning
m-learn
learning using information and communication technologies in mobile contexts

3.9
mobile context
learning can occur in any location because of the portability of the mobile technology

3.10
mobile technology
lightweight devices that learners can conveniently take anywhere to learn and mobile network that learners can access from anywhere

3.11
massive open online course
MOOC
free open online course that is available for anyone to enrol and complete

3.12
nomadic learner
learner who moves from one location to another with relative frequency

EXAMPLE The learner has to access the learning materials from different locations, varying time zones and within another environment during a single learning episode.

3.13
responsive design
method for web page construction to detect the user's screen size and orientation and dynamically change the layout accordingly

3.14
seamless learning
learning in different contexts using multiple devices

3.15
ubiquitous learning
learning that is stimulated and supported through diverse channels and always readily accessible

3.16
virtual reality
artificial environment presented using computer technologies

Note 1 to entry: Virtual reality has a high level of immersiveness, fidelity of information representation, and degree of active learner participation compared to other forms of mixed reality.

4 Abbreviated terms

ICT	information and communication technology
ITLET	information technology for learning, education and training
LET	learning, education and training
LMS	learning management system
OS	operating system

5 Examples of mobile learning applications

5.1 Examples in this document

Annexes A through I provide nine use cases that describes the use of mobile technology in learning, education and training.

Annex A: Online student use of mobile devices for learning

A longitudinal and cross-sectional mixed methods study employing the community of inquiry (CoI) and framework for the rational analysis of mobile education (FRAME) models to examine the use of mobile devices among graduate students at one online North American university.

Annex B: Fluent speaking in English/fluent reading

An English-speaking mobile learning application to train learners to improve their English speaking skills. It uses WeChat™ [1], which is a free application that provides instant messaging services for smart devices. It supports fast access of free video consumption, video and image over the network

1) WeChat™ is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO or IEC of this product.

(communicating a small amount of network traffic) across the communication carrier and cross-operating system platform. At the same time, it can also use the material and location-based social plug-in to share streaming media content.

Annex C: Digital textbook for innovative learning

The Ministry of Education in South Korea and KERIS developed and implemented digital textbooks in an advanced form that overcome the limitations of paper textbooks, improve classroom lessons, and enable personalized teaching and learning. The digital textbooks can be accessed by mobile technologies.

Annex D: Mobile learning technology among final year medical students

A cross-sectional descriptive study conducted among final year undergraduate students at the University of Nairobi, College of Health Sciences. This study aimed to assess the use of mobile learning technology by final year undergraduate students at the College of Health Sciences, University of Nairobi as well as exploring the challenges that impede adoption of mobile learning technology in the target population.

Annex E: Augmented reality training system

Scope AR™[2)] developed an augmented reality training program to train industrial sales and service workers on how to dismantle and re-assemble an accentuator valve. The trainee used iPads®[2)] or augmented reality glasses or both with positioning markers to overlay holographic, step-by step instructional images on a real-world accentuator valve to dismantle and re-assemble the valve. The project was evaluated using a pragmatic mixed-methods approach.

Annex F: App for exam practice

Malezi exam practice is a mobile friendly web application that generates examination revision content for learning and testing readiness for final level exams in both primary and secondary school.

Annex G: Implementation of app for academic success

Integrity Matters™[2)] is a tri-lingual (English, French, Chinese) mobile learning application designed to facilitate anytime, anywhere academic integrity training. The Integrity Matters™ project is designed to improve student engagement with academic material by exploring mobile learning to better resonate with the university/college student population. The app has the capacity to provide an e-certificate and digital badge upon successful completion of the module lessons.

Annex H: Tutoring, games and applications for language learning

The purpose of the FirstVoices mobile applications for language learning (MALL) is to preserve and to promote first nation languages. Over 60 Aboriginal languages are archived, some only available to members of that community. The resources are used by first nations communities in Canada to teach, learn and document their words, phrases, songs, stories and other digital community resources. FirstVoices serves as central language data platform for other applications as well.

Annex I: Evaluation of key factors that affect learner-empowered emergent technology integration

This dissertation sought to determine what key institutional, curricular, instructional and contextual factors and, ultimately, what educational paradigm most enabled online graduate level learners to integrate emergent technologies for learning on demand.

5.2 Other examples of mobile technology for learning

As the use of mobile technologies grows around the world, the infrastructure to support mobile learning is being improved to allow access anywhere and anytime to learning applications, services and content. In several countries, corporate, academic and government organizations are using existing

2) Scope AR™, iPad® and Integrity Matters™ are examples of suitable products available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO or IEC of these products.

learning management systems to implement and provide support for mobile learning. In some countries connectivity is sufficient to allow learners to access learning resources and participate in teaching and learning activities through connecting to networks using mobile devices. There is a shift from wired to wireless connection that will facilitate the use of mobile technology in learning. Mobile learning is being used to improve access to learning materials and services that will facilitate individual learning, education and training from anywhere and at any time. Additional examples of mobile learning applications:

— Educational organizations are making their digital learning materials available as open access so that the materials can be re-used at no cost providing the materials are used for education. In most cases, the materials can be accessed using mobile technologies.

— Use of artificial intelligence to adapt learning to meet individual learner needs.

— Organizations are developing and delivering MOOCs, which are free for anyone to participate. In some cases, learners can complete the MOOCs using mobile technologies.

— Countries and organizations are using mobile technologies to educate refugees who live in camps and cannot go to school, so that they can get the knowledge and skills to be integrated into society.

— In large geographically dispersed countries, mobile technologies are used to facilitate the delivery of information and learning materials to learners in any geographic location. Universities are developing digital repositories that have courses that link to learning resources, allowing learners to access course materials from anywhere and at any time using a variety of technologies, including mobile technology.

— Mobile learning is being used to train immigrants who require language instruction in a second language while they work at the same time.

— Organizations are converting courses for mobile delivery for the convenience of learning at a time and place that meets individual learners' needs.

— Mobile learning applications are being used to:

  — Send daily information from schools and universities to students.

  — Gather immediate feedback and response data from students using mobile phones as part of a classroom response system.

  — Assess learner levels of understanding or skills, associated with rich media content.

  — Browse videos of recorded lectures.

  — Support problem-based or collaborative learning in real situations, such as exploring museums or cities to find out relevant information to solve a given problem.

  — Support interactions with an intelligent software agent capable of adapting to the heterogeneous mobile computing environment. The agent can search for a conversion tool according to the desired format and convert the course materials automatically. The agent is able to understand mobile clients' device capabilities. In order for the server to know what type of course material the client wishes to receive, the client needs to provide information on the software and hardware capabilities of the device to the server. However, devices do not normally carry any information about their capabilities with respect to affordances available for learning, education and training activities.

6 Learner information for mobile learning

6.1 General

Information about the learner is used to determine how required learning materials infrastructure and support are all tailored for mobile learning. Learner information for mobile learning is similar to learner information for e-learning. Additional learner information is required to support mobile learning in different situations that may reflect contextual elements such as the mobility of the learner and the nature of the surrounding environment (e.g. infrastructure to support ubiquitous learning). As noted by several leading researchers in the field, the use of mobile devices to support mobile learning can be considered along different dimensions including the mobility of the learner and the embeddedness of the learner in the real environment or in context. In e-learning with desktop or notebook computers, the learner mobility and embeddedness are low. In mobile learning, learner mobility and embeddedness are high.[15] To adequately support mobile learners engaged in learning, education and training activities, information technology systems need to consider the specific context of the mobile learner with respect to dimensions such as mobility, embeddedness, learner preferences, content, device capabilities, connectivity and coordination.

Mobile learning provides flexibility for learning since it enables learning facilitated by a diversity of mobile devices. Mobile learning content is delivered in chunks and the mobile device can allow for synchronous, spontaneous interactions. In mobile learning the learner is always connected and learning is networked because of the connectivity of the mobile device[7]; however, the learner may connect for a short time to download an app and then learn using the downloaded app. Mobile learning provides learners with opportunities to learn outside of the classroom or workplace since the learner can learn from anywhere and at any time. Organizations use both e-learning and mobile learning; however, mobile learning provides more flexibility to learn and can allow for improved communications between learners and between learners and teachers.

6.2 Learner information model for mobile learning

During the review of the nine use cases, certain elements were identified as being minimum recommended elements to support learners and others were identified as optional. A more detailed listing of the use cases reviewed is provided in Annexes A through I. Following the review, common aspects were identified and form the basis for the learner information model for mobile learning. Figure 1 shows the support systems for mobile learning more information regarding learner interactions with mobile learning systems is provided in Clause 7.

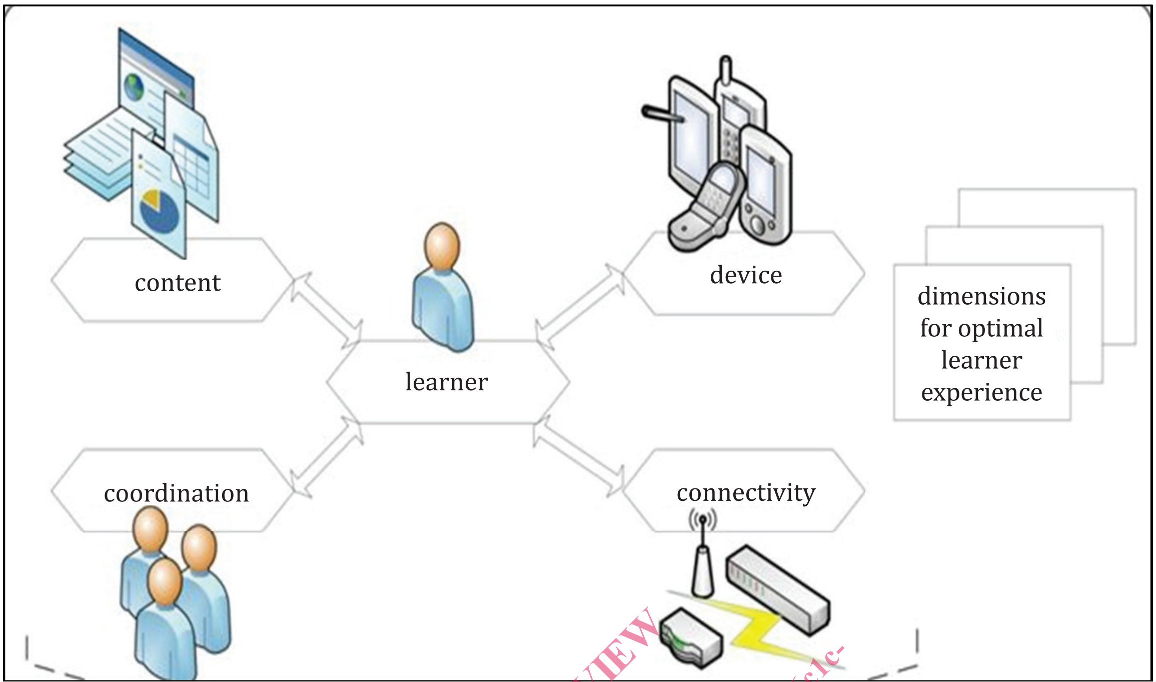

Figure 1 — Learner information model for mobile learning

The learner is at the centre of the mobile learning support systems model. Other aspects that are part of the model and impact on learner experience include content, device, coordination and connectivity. The minumum recommended elements are identified in Table 1 (see subclause 6.3). Each minimum recommended element has been included under the relevant aspect of the learner information model for mobile learning. There are also optional elements included in subclause 6.4 that have been grouped under the related aspect. It should be noted that the list of optional elements is not exhaustive, and is further expanded in subclause 6.5. Ideally, the elements within each aspect of the learner information model for mobile learning are viewed as dimensions that, when considered holistically, can assist in providing an optimal experience for learners engaged in mobile learning activities. It should be noted that mobile learning activities are inherently dynamic, connectivity can change during sessions, learner preferences for presentation can change depending on external factors such as noise in the surrounding environment, or internal factors such as fatigue. Although in-depth details regarding privacy are beyond the scope of this document, several elements have been noted as possibly having potential privacy issues. Further discussion regarding possible technical solutions to these potential privacy issues currently is not included in this document.