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MOBILE ASSESSMENT

State of the Art

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MOBILE ASSESSMENT

New developments in assessment utilizing mobile devices contribute to an ongoing evolution in the context of m-learning. This chapter begins with a brief overview of the computerized assessment procedures that led to mobile assessment. It then defines mobile assessment and its pedagogy and explains relevant design issues and the implementing technologies. Then it describes the main mobile assessment practices used today, as well as their affordances and constraints. This chapter may serve as a useful reference for developers, teachers, trainers, educational administrators, researchers, and others with an interest in mobile assessment.

ASSESSMENT AND COMPUTING

Assessment is considered a fundamental part of the learning process, because teachers can evaluate and classify learners, encouraging and supporting the learning procedure (Ellis, 2001). The commonest distinction among assessment types in the literature is that made between formative assessment and summative assessment. A summative assessment certifies learning and reports about students' progress at the end of a unit or a course. It is usually referred to as assessment *of* learning. A formative assessment can be defined as activities undertaken by teachers and/or their students that provide information to be used as feedback, to modify the teaching and learning activities in which they are engaged (Black & William, 1998). It is usually refer to as assessment *for* learning.

Beyond paper- and pencil-based assessment, it can be computer assisted also. Computer-assisted assessment/computer-aided assessment (CAA) or computer-based testing (CBT) makes use of computer technology, enabling instructors to deliver, mark, and analyze assignments or exams (Sim, Holifield, & Brown, 2004). Advantages of CAA over paper-based assessment include accuracy, time savings, immediate feedback, enhanced validity, and improved security (Segall, Doolen, & Porter, 2005). The form of CAA that adapts to the examinee's ability level is called computer-adaptive testing (CAT). The basis for CAT systems is the Item Response Theory (IRT), which defines the relationship between examinees and items through mathematical models. The difficulty of each item is matched to the learner's knowledge level with adaptive item sequencing. The main advantage of computerized adaptive tests is that each examinee usually receives different questions than other examinees, with the total number of questions in a CAT usually smaller than the number of questions needed in a classic test. The majority of current CAT systems give priority to security, reliability, and maintainability, while they almost ignore issues related to presentation, functionality, and feedback (Economides & Roupas, 2007). Seventeen criteria for the evaluation of an adaptation engine (Economides, 2007) and twenty-one adaptive-feedback attributes (Economides, 2006a) could be considered in order for the designers and developers of CAT systems to produce effective feedback adapted to the learner or the educational context. The introduction of mobile devices to assessment practices has led to the development of a new form of assessment, the mobile assessment.

DEFINING MOBILE ASSESSMENT

Mobile device-based assessment is called mobile assessment (m-assessment). A range of mobile devices, such as laptops, netbooks, tablet PCs, and handhelds (PDAs, palmtops, mobile phones, and smartphones) facilitate exams across contexts, "anytime and anywhere." Taking into consideration the corresponding m-learning characteristics (Sharples, Taylor, & Vavoula, 2005; Traxler, 2005), m-assessment can also be characterized as: personalized, informal, learner-centered, collaborative, ubiquitous, bite-sized, lightweight, on demand, typically blended, situated, and context-aware.

M-ASSESSMENT PRACTICES

Different assessment practices can be conducted using mobile devices: classroom response systems, self-assessment, peer assessment, collaborative assessment, computerized adaptive testing on mobile devices, dynamic assessment, context-aware and location-aware assessment, as well as mobile game-based learning (mGBL) assessment.

Classroom Response Systems

Electronic classroom response systems (CRSs), audience response systems (ARSs), or synchronous e-voting systems (usually called "clickers") are small, wireless, specialized keypads, mobile phones, or handhelds used by students as an alternative method of "showing your hands" to answer questions posed by instructors. The responses (anonymous or not) can be aggregated and presented for class discussion. Individualized feedback to students is also possible. Examples of CRSs are Votapedia (Maier, 2009), TXT-2-LRN (Scornavacca, Huff, & Marshall, 2007), and Classroom Presenter (Anderson et al., 2004; Koile & Singer, 2006). When coupled with appropriate pedagogical methodologies, these systems can promote learning (Fies & Marshall, 2006), because they increase student engagement (through anonymity of data submission to the group), participation and attentiveness (all students can potentially answer all questions), interaction (the lecturer has immediate access to students' answers), and satisfaction

(Davis, 2003). They also provide an effective formative-assessment mechanism, where course material largely depends on student feedback, and students can work out misconceptions via peer or classroom discussion (Kay & Lesage, 2009). Although success with synchronous surveys in class is very well documented, asynchronous electronic surveys, usually conducted to gather feedback before or after teaching sessions, need to be evaluated (Tong, 2011).

Self- and Peer Assessment

Self- and peer assessment helps students monitor their own learning. Not much research about how to use mobile technology for self- and peer assessment has been reported. In m-assessment systems for self- and peer classroom assessment, students showed increased motivation, improved achievements, and positive acceptance, with the assessment procedure found to be flexible, convenient, and time-saving (Chen, 2010; de-Marcos et al., 2010).

Collaborative Assessment

Collaborative learning is a new educational approach where students work together in groups to improve their understanding of a subject. Computer-supported collaborative learning (CSCL) uses computer technology to support knowledge construction and sharing among participants (Stahl, Koschmann, & Suthers, 2006). The introduction of mobile devices in CSCL, as well as intelligent support tools in assessment, has great potential to contribute to the development of innovative forms of collaborative assessment (Gay, Stefanone, Grace-Martin, & Hembroke, 2001; Strijbos, 2011). Handhelds can facilitate the complex task of assessing group work (Yarnall et al., 2003). Furthermore, even examinations can be designed collaboratively (Swan, Shen, & Hiltz, 2006). Collaborative learning, including assessing students' knowledge, can also be conducted outdoors, in places with no pre-installed infrastructure, such as wilderness, national parks, and archaeological sites (Vasiliou & Economides, 2007a).

Computerized Adaptive Tests on Mobile Devices

The main components of a computerized-adaptive-tests-on-mobile-devices (CAT-MD) system are the item pool, the item selection procedure, the ability estimation, and the stopping rule (Triantafillou, Georgiadou, & Economides, 2008a). According to the general framework for adaptive m-learning by Economides (2006b), an adaptation engine acquires the context of the mobile learner as input data and accordingly personalizes the educational activity and/or the infrastructure. The adaptation procedure can produce a personalized exam adapted to the examinee's ability level, or even a dynamic-assessment module, and, furthermore (when the context relates to a ubiquitous environment), a context-aware assessment.

Dynamic Assessment (DA)

The dynamic-assessment (DA) strategy integrates assessment with instruction, providing teaching assistance during assessment, and thus supporting the idea of "assessment as teaching and learning strategy." It can have the "sandwich format" (pre-test, teach, and post-test) or the "cake format," where assessment is interwoven with teaching (Sternberg & Grigorenko, 2001). A DA approach can effectively support student learning in the field, by providing instant feedback when students need it, according to their performance evaluated by the DA (Chen, Chen, & Lin, 2009). GPS-embedded mobile devices, wireless networks, and radio-frequency identification (RFID) technology are potential enablers for the implementation of DA in any authentic situation. A Web-based DA system enables learners with low-level prior knowledge to experience more effective learning (Wang, 2010), and a decision-tree approach for such a DA had a positive effect on student motivation (Huang, Wu, Chu, & Hwang, 2008).

Context-Aware Assessment

A system is context aware if it can extract, interpret, and use context information and adapt its functionality to the current context of use (Byun & Cheverst, 2004). The context consists of the learner state, the educational-activity state, the infrastructure state, and the environment state (Economides, 2008, 2009). In order to facilitate the development of context-aware systems, relevant principles and models were described (Baldauf, Dustdar, & Rosenberg, 2007), and frameworks were analyzed (Martin et al., 2011). Twelve models for assessing the learning performance of the students, based on their real-world and online behaviors, are proposed in Hwang and Tsai (2011). In a context-aware u-learning environment, RFID-sensor technologies (Curtin, Kauffman, & Riggins, 2007), embedded in mobile devices, along with wireless networks, detect the environment and interact with students, guiding and assessing them as they are engaged in the learning activity (Liu & Hwang, 2010). Experimental results from real-world learning contexts indicate improved student-learning achievement, promoting the learning attitude (Chu, Hwang, Tsai, & Tseng, 2010; Hwang & Chang, 2011).

Location-Aware Assessment

Location-aware systems constitute a subfield of context-aware computing. These systems can sense the current location of a user and change behavior based on this location, using Wi-Fi or mobile-phone triangulation, GPS, or RFID. Evaluation of "assessment in situ (e.g., location)," using geo-located questions with GPS-enabled mobile devices, shows increased student motivation, reflection, and personal observation (Santos, Pérez-sanagustín, Hernández-leo, & Blat, 2011). The integration of location-aware services and Web 2.0 may offer great innovations in the delivery of education in the future (Cochrane & Bateman, 2010).

mGBL Assessment

Players use mobile phones as well as RFID and near-field communication (NFC) technologies to interact with a game scenario in any location (pervasive games). The assessment may have the form of explicit questions to be answered, or it may be based on the level of performance that the player reaches while playing. mGBL is mapped with existing learning theories (Zaibon & Shiratuddin, 2009). Examples from the literature (Garrido, Miraz, Ruiz, & Gómez-Nieto, 2011; Wang, Øfsdahl, & Mørch-Storstein, 2008) indicated that mGBL contributes to increased learning and motivation.

Several pedagogical principles and learning theories are combined in each m-assessment practice. Table 30.1 presents the relationship between learning theories and m-assessment practices (Naismith, Lonsdale, Vavoula, & Sharples, 2004; Orr, 2010; Ryu & Parsons, 2009).

Table 30.1 Learning Theories Along With Mobile Assessment Practices

Learning theory practice	Main feature	Example of m-assessment
Behaviorism	Immediate feedback provides the opportunity to adjust the learning behavior	CRS, CAT-MD, dynamic, context aware
Constructivism	Students construct their own knowledge based on interactions with the environment	Context and location aware, mGBL, collaborative
Situated learning	Learning takes place in authentic learning environments	
Collaborative learning	Learning is based on social interactions	Self- and peer assessment, collaborative

DESIGN AND IMPLEMENTATION TECHNOLOGIES

Design

The most popular standards available for m-learning and m-assessment are the Shareable Content Object Reference Model (SCORM) and the IMS Question and Test Interoperability Model. The first model enhances content's interoperability and reusability among learning objects. The second one defines a specification for representing questions and the reporting of results, allowing the exchange of data (item, test, and results) between multiple IT systems (Álvarez-gonzález, Araya, Nuñez, & Cárdenas, 2011; Zhang, Wills, & Gilbert, 2010).

Implementation

M-assessment systems can be delivered through short message service (SMS) client-server and mobile ad hoc networks (MANETs) implementations.

SMS

This is a text-messaging service between mobile-phone devices. It can be used as a quiz tool (fill in blanks, true/false, multiple-choice questions), with usually automated feedback. SMS technology fits to m-learning because it has low cost and is available on all mobile phones, and students are already familiar with it (Tretiakov & Kinshuk, 2005). Successful implementations of SMS assessment systems provide an additional channel of communication between teacher and students, making class more interactive and interesting; improve student examination performance (Morris, 2010); enhance formative assessment and feedback (Nagowah, Meghoo, & Gaonjur, 2010); and enrich the learning experience in general (Yengin, Karahoca, Karahoca, & Uzunboylu, 2011). SMS-based assessment systems could also be integrated with learning and exam-management systems (Riad & El-Ghareeb, 2008).

Client-Server

Another implementation of mobile exam systems links mobile application interfaces (clients) to XML database-management systems (servers) via a wireless communication system. The typical flow in such an m-assessment system includes the following steps: the teacher uploads questions to the server; the student downloads the m-assessment application to his/her phone and responds to the questions; the server tabulates scores and presents them to the teacher and/or the student. Such implementations (Cavus & Al-momani, 2011; Kim et al., 2010; Lu, Sundaram, Zhaozong, Arumugam, & Gehao, 2011; Madeira, Pires, Dias, & Martins, 2010; Otair, Tawfiq, Al-Zoubi, & Alkouz, 2008) have the following key advantages: location and device independence of application logic, centralized software maintenance and data management, fast data storage and retrieval to support a large number of concurrent users, multimedia support, and different privilege levels (instructor and learner).

MANET

In a MANET, there is no need for pre-installed infrastructure. Each mobile device is free to move independently, changing its links to other devices acting as server, receiver, and router. Mobile classrooms based on the instructional device of the teacher and the learning devices of the students can be "dynamically constructed" in both indoor and outdoor environments (Chang, Sheu, & Chan, 2003). Multicast MANETs, with their flexible and adaptive architecture, provide reliable and efficient communication, facilitating collaboration among teachers and students in places without communication infrastructure (Mamoukaris & Economides, 2003; Vasiliou & Economides, 2008).

AFFORDANCES AND CONSTRAINTS

The additional channel of assessment using small portable devices that facilitate "testing on demand" has both affordances and constraints resulting from the special characteristics of these new assessment media.

Affordances

The main affordances of m-assessment are described below:

- *Context awareness*: M-assessment can be conducted "anywhere and at anytime," in the classroom or in the field, in a ubiquitous fashion (Economides, 2009; Soloway, Norris, Blumenfeld, Fishman, & Marx, 2001), "providing access to tools and information within the context of learning activities" (Luchini, Quintana, & Soloway, 2004, p. 135).
- *Adaptability*: Development and evaluation of computerized adaptive testing on mobile devices (Triantafillou, Georgiadou, & Economides, 2008b) proved to be an effective, efficient, accurate, exact, and reliable formative-assessment tool.
- *Personalization*: Adaptability and differentiated instruction lead to a more personalized learning experience (Looi et al., 2009). Wireless communication devices equipped with sensors detect users and environment information in order to provide personalized services (Economides, 2009).
- *Feedback*: Mobile devices facilitate formative-assessment practices giving the opportunity for many assessment sessions during instruction. Immediate instructor feedback supports students as independent, self-motivated, and self-regulated learners (Al-smadi & Guetl, 2011), a primary goal for 21st-century education. Also, student feedback enables instructors to adjust course material in real time, avoiding any misconceptions (Koile, & Singer, 2006).
- *Collaboration*: Mobile devices can enhance online collaborative-learning activities and assessment strategies (group work, outdoor learning), supporting an active-learning environment (Vasiliou & Economides, 2007b).

- *Multiple uses*: PDAs as multimedia access tools, communication tools, capture tools, representational tools, or analytical tools (Churchill & Churchill, 2008) offer new potentials in m-assessment such as richer assessment items and feedback and, hence, more realistic testing environments.
- *Efficiency*: The efficiency (time it took students to complete a quiz) was found to be superior for the PDA-based assessment compared with the paper and pencil quiz, whereas no differences in effectiveness (students' test scores) were found between the two quiz types (Segall, Doolen, & Porter, 2005). Treadwell (2006) indicates that students express a high level of satisfaction with a PDA-based assessment system.
- *Anonymity*: Anonymous answer submission increases learners' self-confidence to be engaged in discussions (Atewell, 2005).
- *Cost*: Mobile devices are usually less expensive than desktops or laptops (Allan, Carbonaro, & Buck, 2006; Traxler, 2004).

Constraints

The main constraints of m-assessment are basically the physical attributes of the mobile devices:

- Small screen size with limited input capabilities has a negative effect in the usability of the mobile devices (Maniar, 2007).
- Other usability constraints include limited battery life, limited storage capacity and computational power, interface limitations, and inconvenient input (Chen, Chang, & Wang, 2008).
- Platform inconsistency among mobile devices and connectivity issues may be also a barrier (Churchill & Hedberg, 2008).
- Security issues should also be considered, such as device lost or theft, data vulnerability, and privacy.

CONCLUSIONS

M-assessment has been implemented so far in different disciplines and subject contexts such as K–12 and higher education, environmental and engineering education, outdoors, inquiry science learning, virtual experiments, museum visits, workplaces, and health care. Despite the difficulties and constraints, the general outcome is that it can enhance the assessment procedure and complement both e-assessment and traditional assessment and, hence, boost the learning experience. This is mainly because it enables more frequent formative assessment and it can be conducted in any authentic learning environment, providing personal learning support and improving instruction. However, problems such as access, pedagogical support, administrative encouragement, and perceived reliability often stand as barriers to its greater adoption (Penuel, Tatar, & Roschelle, 2004) and, thus, must be overcome. Developers and instructors should cooperate in order to produce quality m-assessment practices, while educational administrators and policymakers would encourage its adoption.

REFERENCES

Allan, C., Carbonaro M., & Buck G. (2006). A survey of Personal Digital Assistants (PDAs) use in a middle school environment: Perceptions of teachers, parents and students. *Meridian Middle School Computer Technologies Journal*, *2*(9).

Al-smadi, M., & Guetl, C. (2011). Supporting self-regulated learners with formative assessments using automatically created QTI- questions. *Global Engineering Education Conference (EDUCON)*, 2011 IEEE, 288–294.

Álvarez-gonzález, L. A., Araya, E., Nuñez, R., & Cárdenas, F. (2011). Blue-QTI: A mobile learning system using bluetooth and IMS QTI specification. *eL&mL 2011 : The Third International Conference on Mobile, Hybrid, and On-line Learning*, Gosier, Guadeloupe, France.

Anderson, R., Anderson, R., Simon, B., Wolfman, S. A., VanDeGrift, T., & Yasuhara, K. (2004). Experiences with a tablet PC based lecture presentation system in computer science courses. *ACM SIGCSE Bulletin*, *36*(1), 56.

Attewell, J. (2005). *From research and development to mobile learning: Tools for education and training providers and their learners.* Paper presented at mLearn 2005, 4th World Conference on Mobile Learning, Cape Town, South Africa.

Baldauf, M., Dustdar, S., & Rosenberg, F. (2007). A survey on context-aware systems. *International Journal of Ad Hoc and Ubiquitous Computing*, *2*(4), 263–277.

Black, P., & William, D. (1998). Assessment and classroom learning. *Assessment in Education. Principles, Policy & Practice*, *5*(1), 7–74.

Byun, H. E., & Cheverst, K. (2004). Utilizing context history to provide dynamic adaptations. *Applied Artificial Intelligence*, *18*(6), 533–548.

Cavus, N., & Al-momani, M. M. (2011). Mobile system for flexible education. *Procedia Computer Science*, *3*, 1475–1479.

Chang, C. Y., Sheu J. P., & Chan, T. W. (2003). Concept and design of ad hoc and mobile classrooms. *Journal of Computer Assisted Learning*, *19*, 336–346.

Chen, C. H. (2010). The implementation and evaluation of a mobile self- and peer-assessment system. *Computers & Education*, *55*(1), 229–236.

Chen, G. D., Chang, C. K., & Wang, C. Y. (2008). Ubiquitous learning website: Scaffold learners by mobile devices with information-aware techniques. *Computers and Education*, *50*, 77–90.

Chen, C., Chen, C., & Lin, T. (2009). Dynamic assessment of fieldwork. *Development*, 1–8.

Chu, H. C., Hwang, G. J., Tsai, C. C., & Tseng, J. C. R. (2010). A two-tier test approach to developing location-aware mobile learning systems for natural science courses. *Computers & Education*, *55*(4), 1618–1627.

Churchill, D., & Churchill, N. (2008). Educational affordances of PDAs: A study of a teacher's exploration of this technology. *Computers & Education*, *50*(4), 1439–1450.

Churchill, D., & Hedberg, J. (2008). Learning object design considerations for small-screen handheld devices. *Computers & Education*, *50*(3), 881–893.

Cochrane T., & Bateman, R. (2010). Smart phones give you wings: Pedagogical affordances of mobile Web 2.0. *Australasian Journal of Educational Technology*, *26*(1), 1–14.

Curtin, J., Kauffman, R. J., & Riggins, F. J. (2007). Making the "MOST" out of RFID technology: A research agenda for the study of the adoption, usage and impact of RFID. *Information Technology and Management*, *8*(2), 87–110.

Davis, S. (2003). Observations in classrooms using a network of handheld devices. *Journal of Computer Assisted Learning*, *19*(3), 298–307.

Ellis, A., (2001). *Teaching, learning, and assessment together: The reflective classroom.* Larchmont, NY: Eye on Education.

Economides, A. A. (2006a). Adaptive feedback characteristics in CAT (Computer Adaptive Testing). *International Journal of Instructional Technology & Distance Learning*, *3*(8), 15–26.

Economides, A. A. (2006b, November). *Adaptive mobile learning.* Fourth IEEE International Workshop on Wireless Mobile and Ubiquitous Technology in Education WMTE06, Athens, 26–28.

Economides, A. A. (2007). On evaluation of adaptation engines. In V. Uskov (Ed.), *10th International Conference on Computers and Advanced Technology in Education (CATE 2007)*, October 8–10. Beijing, China.

Economides, A. A. (2008). Context-aware mobile learning. *The Open Knowledge Society, A Computer Science and Information Systems Manifesto, First World Summit, WSKS 2008*, Athens, Greece, September 24–26. Proceedings. SPRINGER Communications in Computer and Information Science (CCIS), *19*, 213–220.

Economides, A. A. (2009). Adaptive context-aware pervasive and ubiquitous learning. *International Journal of Technology Enhanced Learning, 1*(3), 169–192.

Economides, A. A., & Roupas, C. (2007). Evaluation of computer adaptive testing systems. *International Journal of Web Web-Based Learning and Teaching Technologies, 2*(1), 70–8.

Fies, C., & Marshall, J. (2006). Classroom Response Systems: A review of the literature. *Journal of Science Education and Technology*, *15*(1), 101–109.

Garrido, P. C., Miraz, G. M., Ruiz, I. L., & Gómez-Nieto, M. A. (2011). Use of NFC-based pervasive games for encouraging learning and student motivation. *Third International Workshop on Near Field Communication*, Hagenberg, Austria, 32–37.

Gay, G., Stefanone, M., Grace-Martin, M., & Hembrooke, H. (2001). The effects of wireless computing in collaborative learning environments. *International Journal of Human-Computer Interaction*, *13*(2), 257–276.

Huang, S. H., Wu, T. T., Chu, H. C., & Hwang, G. J. (2008). A decision tree approach to conducting dynamic assessment in a context-aware ubiquitous learning environment. *Fifth IEEE International Conference on Wireless, Mobile and Ubiquitous Technology in Education*, 89–94.

Hwang, G. J., & Chang, H. F. (2011). A formative assessment-based mobile learning approach to improving the learning attitudes and achievements of students. *Computers & Education*, *56*(4), 1023–1031.

Hwang, G. J., & Tsai, C. C. (2011). Research trends in mobile and ubiquitous learning: A review of publications in selected journals from 2001 to 2010. *British Journal of Educational Technology*, *42*(4), 65–70.

Kay, R. H., & Lesage, A. (2009). A strategic assessment of audience response systems used in higher education. *Australasian Journal of Educational Technology*, *25*(2), 235–249.

Kim, S., Schap, T., Bosch, M., Maciejewski, R., Delp, E. J., Ebert, D. S., et al. (2010). Development of a mobile user interface for image-based dietary assessment. *Health San Francisco*, 0–6.

Koile, K., & Singer, D. (2006). Improving learning in CS1 via tablet-PC-based in-class assessment. *Proceedings of the 2006 International Workshop on Computing Education Research ICER 06*, 119.

Liu, G. Z., & Hwang, G. J. (2010). A key step to understanding paradigm shifts in e-learning: Towards context-aware ubiquitous learning. *British Journal of Educational Technology*, *41*(2), 1–9.

Looi, C. K., Wong, L. H., So, H. J., Seow, P., Toh, Y., Chen, W., et al. (2009). Anatomy of a mobilized lesson: Learning my way. *Computers & Education*, *53*(4), 1120–1132.

Luchini, K., Quintana, C., & Soloway, E. (2004). Design guidelines for learner-centered handheld tools. *Proceedings of the 2004 Conference on Human Factors in Computing Systems CHI 04*, *6*(1), 135–142

Lu, J., Sundaram, A., Zhaozong, M., Arumugam, V., & Gehao, L. (2011, June). Mobile exam system—MES: Architecture for database management. *The International Conference on Education & Learning in Mobile Age—CELMA*, June 1–2, Lake District, UK.

Madeira, R. N., Pires, V.F., Dias, O.P., & Martins, J.F. (2010). Development of a mobile learning framework for an analog electronics course. *Engineering Education*, 561–567.

Maier, H. R. (2009). Student participation in lectures using mobile phones. *Engineering Education*, 43–48.

Mamoukaris, K. V., & Economides, A. A. (2003). Wireless technology in educational system. *11th International PEG Conference*, Russia, 28/6–1/7

Maniar, N. (2007). M-learning to teach university students. In C. Montgomerie & J. Seale (Eds.), *Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications 2007* (pp. 881–887).

de-Marcos, L., Hilera, J. R., Barchino, R., Jiménez, L., Martínez, J. J., Gutiérrez, et al. (2010). An experiment for improving student's performance in secondary and tertiary education by means of m-learning auto-assessment. *Computers & Education*, *55*, 1069–1079.

Martin, S., Diaz, G., Plaza, I., Ruiz, E., Castro, M., & Peire, J. (2011). State of the art of frameworks and middleware for facilitating mobile and ubiquitous learning development. *The Journal of Systems & Software*, *84*(11), 1883–1891.

Morris, N. P. (2010). Podcasts and mobile assessment enhance student learning experience and academic performance. *Bioscience Education*, *16* (1).

Nagowah, S., Meghoo, L., & Gaonjur, K. (2010). A mobile framework for formative assessment for first year students. *3rd IEEE International Conference on Computer Science and Information Technology (ICCSIT)*, *4*, 492–499.

Naismith, L., Lonsdale, P., Vavoula, G., & Sharples, M. (2004). Literature review in mobile technologies and learning. *FutureLab Report*, *11*.

Orr, G. (2010). A review of literature in mobile learning: Affordances and constraints. *6th IEEE International Conference on Wireless Mobile and Ubiquitous Technologies in Education*, 107–111.

Otair, M., Tawfiq, A., Al-Zoubi, A. Y., & Alkouz, A. (2008, April). A mobile quiz system for assessment of the learning process. *3rd International Conference on Mobile and Computer Aided Learning, IMCL*, April 16–18, Jordan.

Penuel, W. R., Tatar, D. G., & Roschelle, J. (2004). The role of research on contexts of teaching practice in informing the design of handheld learning technologies. *Journal Educational Computing Research*, *30*(4), 353–370.

Riad, A., & El-Ghareeb, H. (2008). A service oriented architecture to integrate mobile assessment in learning management systems. *Turkish Online Journal of Distance Education-TOJDE*, *9*(2), 200–219.

Ryu, H., & Parsons, D. (2009). Designing learning activities with mobile technologies. *Innovative Mobile Learning Techniques and Technologies*, *64*(0), 1–20.

Santos, P., Pérez-sanagustín, M., Hernández-leo, D., & Blat, J. (2011). QuesTInSitu: From tests to routes for assessment in situ activities. *Computers & Education*, *57*(4), 2517–2534.

Scornavacca, E., Huff, S., & Marshall, S. (2007). Developing a SMS-based classroom interaction system. In D. Parson & H. Ryu (Eds.), *Proceedings of the Conference on Mobile Learning Technologies and Applications MoLTA*, 47–54.

Segall, N., Doolen, T., & Porter, J. (2005). A usability comparison of PDA-based quizzes and paper-and-pencil quizzes. *Computers & Education*, *45*(4), 417–432.

Sharples, M., Taylor, J., & Vavoula, G. (2005). Towards a theory of mobile learning. *Mind*, *1*(1), 1–9.

Sim, G., Holifield, P., & Brown, M. (2004). Implementation of computer assisted assessment: Lessons from the literature. *AltJ*, *12*(3), 215–229.

Soloway, E., Norris, C., Blumenfeld, P., Fishman, B. J., & Marx, R. (2001). Devices are ready-at- hand. *Communications of the ACM*, *44*(6), 15–20.

Stahl, G., Koschmann, T., & Suthers, D. (2006). Computer-supported collaborative learning: An historical perspective. In R. K. Sawyer (Ed.), *Cambridge handbook of the learning sciences* (pp. 409–426).

SternBerg, R. J., & Grigorenko, E. L. (2001). All testing is dynamic testing. *Issues in Education*, *7*, 137–170.

Strijbos, J. W. (2011). Assessment of (computer-supported) collaborative learning. *IEEE Transactions on Learning Technologies*, *4*(1), 59–73.

Swan, K., Shen, J., & Hiltz, S. R. (2006). Assessment and collaboration in online learning. *Journal of Asynchronous Learning*, 45–62.

Tong, V. C. H. (2011). Using asynchronous electronic surveys to help in-class revision: A case study. *British Journal of Educational Technology*, DOI:10.1111/j.1467–8535.2011.01207.x

Traxler, J. (2004). Mobile learning—Evaluating the effectiveness and the cost. In J. Attewell & C. Savil-Smith (Eds.), *Learning with mobile devices* (pp. 183–188), London: Learning and Skills Development Agency.

Traxler, J. (2005). Defining mobile learning. *Learning*, *40*, 261–266.

Treadwell, I. (2006). The usability of personal digital assistants (PDAs) for assessment of practical performance. *Medical Education*, *40*, 855–861.

Tretiakov, A., & Kinshuk, K. (2005). Creating a pervasive testing environment by using SMS messaging. *IEEE International Workshop on Wireless and Mobile Technologies in Education WMTE05*, *1*, 62–66.

Triantafillou, E., Georgiadou, E., & Economides, A. A. (2008a). CAT-MD: Computerized adaptive testing on mobile devices. *International Journal of Web-Based Learning and Teaching Technologies* (extended versions of the best papers presented at m-ICTE2006 Conference), *3*(1), 13–20.

Triantafillou, E., Georgiadou, E., & Economides, A. A. (2008b). The design and evaluation of a computerized adaptive test on mobile devices. *Computers & Education*, *50*, 1319–1330.

Vasiliou, A., & Economides, A. A. (2007a). Mobile collaborative learning using multicast MANETs. *Information Journal of Mobile Communications*, *5*(4), 423–444.

Vasiliou, A., & Economides, A. A. (2007b). Game-based learning using MANETs. In N. Mastorakis & Ph. Dondon (Eds.), *Proceedings of the 4th WSEAS/ASME International Conference on Engineering Education (EE'07)* (pp. 154–159). Agios Nikolaos, Crete, Greece.

Vasiliou, A., & Economides, A. A. (2008, April). MANET-based outdoor collaborative learning. In M. E. Auer & A. Y. Al-Zoubi (Eds.), *3rd International Conference on Interactive Mobile and Computer Aided Learning (IMCL)*, Amman, Jordan, April 16–18, International Association of Online Engineering.

Wang, A. I., Øfsdahl, T., & Mørch-Storstein, O. K. (2008). An evaluation of a mobile game concept for lecturers. *IEEE 21st Conference on Software Engineering Education and Training*, 197–204.

Wang, T. H. (2010).Web-based dynamic assessment: Taking assessment as teaching and learning strategy for improving students' e-Learning effectiveness. *Computers & Education*, *54*, 1157–1166.

Yarnall, L., Penuel, W., Ravitz, J., Murray, G., Means, B., & Broom, M. (2003). Portable assessment authoring: Using handheld technology to access collaborative inquiry. *Education, Communication & Information*, *3*(1).

Yengin, I., Karahoca, A., Karahoca, D., & Uzunboylu, H. (2011). Is SMS still alive for education: Analysis of educational potentials of SMS technology? *Procedia Computer Science*, *3*, 1439–1445.

Zaibon, S. B., & Shiratuddin, N. (2009). Towards developing mobile game-based learning engineering model. *Methods*, 649–653.

Zhang, P., Wills, G., & Gilbert, L. (2010). IMS QTIEngine on Android to support mobile learning and assessment. *Design*, 1–8.