USING THE REVISED BLOOM TAXONOMY IN DESIGNING LEARNING WITH MOBILE APPS

Gülay EKREN
Vocational School of Ayancık Sinop University, Sinop, TURKEY

Assist. Prof. Dr. Nilgün OZDAMAR KESKIN
Anadolu University, Open Education Faculty Eskisehir, TURKEY

ABSTRACT

Mobile learning has been reshaping the mobile applications and requesting a different pedagogy. Therefore, the applications designed for mobile learning are expected to be compatible with the desired skills in learning objectives and learning outcomes. It is recommended to determine learning objectives and learning outcomes that supports appropriate pedagogy for mobile learning while designing an application. In this study, the use of the revised Bloom Taxonomy in designing mobile learning applications was evaluated in terms of cognitive processes and learning outcomes for the realization of effective learning. Besides, the benefits of revised Bloom Taxonomy are evaluated on issues such as analyzing the objectives of syllabus or a curriculum, the classification of learning activities according to the learning objectives, the recognition of the relationship between assessment and learning/teaching activities.

This study also introduces a few alternative models apart from revised Bloom’s Taxonomy and presents some discussions about these models. Then, a range of mobile applications has been suggested for open and distance learners.

Keywords: Mobile learning, Mobile learning apps, Revised Bloom’s Taxonomy, Open and distance learning, Mobile pedagogy.

INTRODUCTION

Mobile devices have various functions such as Bluetooth which provides connection to suchlike devices or peripheral devices at a distance of ten meters without needing a wire; the camera, a desktop computer or a laptop etc.

They also have the ability to download any content from internet, sending or receiving email, playing games, instant messaging, watching TV, listening music, using the phone as a modem, using an external memory card, making an audiovisual call, web surfing, using social networking, accessing library resources etc. (Kroski, 2008).
Because of these functions, they are mostly using like a personal assistant or a personal computer. They make learning possible in or out of the traditional classrooms as well as enriching personal and social life (Roschelle, Sharples & Chan, 2005). They also have potential for learning because of these reasons as follows:

- to access everywhere where traditional learning can’t,
- to make learning more user-centered,
- to be considered as a part of blended learning approach,
- to be perceived as an alternative tool to meet learning requirements,
- to increase motivation and commitment in learning,
- to facilitate collaboration and interaction in learning,
- to make learning more attractive and acceptable for disenfranchised learners (Duncan-Howell & Lee, 2007).

Learning with mobile devices provides self-management and self-confidence in learning process. They provide opportunity for recreational learning and also an instant fixing of false drop when improving social learning. Apart from using mobile devices for learning, using Bloom’s Taxonomy for learning also provides benefits such as:

- when examining objectives in terms of both knowledge and cognitive processes,
- objectives, instruction activities and materials, and assessments are each examined in terms of the Bloom’s Taxonomy rather than with each other,
- the Bloom’s Taxonomy enables educators to examine differences in alignment from one subject matter to another or from one grade level to the next (Anderson, 2005:112).

As considered Bloom’s Taxonomy from the view of mobile learning, Stone (2004) offers a framework which affect pedagogic efficacy when transformed learning objects in terms of mobile learning context. He claimed that mobile learning is a great potential for the use of mobile devices in e-learning. Besides, as the nature of mobile learning based on collaborative learning, a mobile application design based on revised Bloom’s Taxonomy supports collaborative learning (Traxler, 2009; Cheong, Bruno and Cheong, 2012). On the other hand, some researchers suggested that the multiple choice questions are suitable to assess e-learning or mobile learning throughout all the six levels of the Bloom’s taxonomy (Govindasamy, 2002; Tsai, Tsai, & Hwang, 2015). Kuo, Chang, Ying and Heh (2011) proposed a worksheet generator to help teachers constructing worksheet based on Bloom’s Taxonomy for mobile learning. They use true/false items and multiple choice items to generate worksheet.

In this study, the use of the revised Bloom Taxonomy in designing mobile learning applications was evaluated in terms of cognitive processes and learning outcomes for the realization of effective learning. In addition, the benefits of revised Bloom Taxonomy are evaluated on issues such as analyzing the objectives of syllabus or a curriculum, the classification of learning activities according to the learning objectives, the recognition of the relationship between assessment and learning/teaching activities.
This study also introduces a few alternative models apart from revised Bloom’s Taxonomy and presents some discussions about these models.

Then, a range of mobile applications has been suggested for open and distance learners.

THE EVOLUTION OF MOBILE LEARNING

Mobile devices, which have been using for mobile learning, can be easily used anytime, anywhere. These electronic devices have been emerging from 1970s to until today.

Because of their dynamic structure, personal electronic devices that could be incorporated into mobile learning are increasing day by day (Table 1.)

Accordingly, the interest in mobile learning is increasing with developments in mobile technologies.

On the other hand, for constituting the nature and possible future of mobile learning, projects, workshops, seminars and a series of conferences are held in worldwide from 2002 to these days such as MLEARN (Mobile Learn), WMT (International Workshop on Mobile and Wireless Technologies in Education), IADIS (International Association for Development of the Information Society), ALT-C (the Association for Learning Technology).

In these studies, learning pedagogy had new definitions with combining the concepts of "learning" and "mobility".

Initially, particularly smart phone and the mobile device was centered the definitions of mobile learning.

The definition of mobile learning has a stable ground overwhelmingly after the emergence of technologies such as wearable technologies and similar technologies (Hamm, Drysdale & Moore, 2014).

In such a study, scientists emphasize that the definition and conceptualization of mobile learning via electronic devices and technologies is not entirely true, it needs some issues such as the mobility of learners, the mobility of learning/the learning experience/the learning process and the mobility of devices (Traxler, 2009; Hamm, Drysdale & Moore, 2014).

As stated by Laouris and Eteokleous (2005), the definition of mobile learning needs a systematic way.

This means, "mobility” and “learning” need to be thought separately, therefore the environment that revealing mobile learning such as communication and interaction with technology, learning environments, philosophy, pedagogy need to be thought. The evolution of mobile learning can be seen in Table 1.
Table 1. Development of mobile technologies in a few decades (Quoted from Crompton, 2014)

<table>
<thead>
<tr>
<th>Years</th>
<th>The Evolution of mobile technologies</th>
</tr>
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</table>
| 1970s | - First mobile phone Motorola DynaTAC 8000X was introduced.  
       - First microcomputer, peripheral devices such as VHS (Video Home System) videotape recorder, floppy disk and object oriented software language named SmallTalk.  
       - GUI (Graphical User Interface) helped to access or run programs without computer codes. |
| 1980s | - To start production of first handheld computers (laptop) in videotape size which run applications such as word processor, spreadsheet, and calendar, address book.  
       - Desktop computers get in place over time.  
       - A connection between computers (networking) was started for social sharing. |
| 1990s | - First web browser, first digital camera and first graphical calculator, multimedia computers as well as palm pilots were began using in educational arrangements.  
       - A palm pilot provides applications such as calculator, notepad, contacts, photos, reminders.  
       - The development of socio-constructivist learning has increased the interest to interact with others and mobility in the scientific communities. |
| 2000s | - Mobile phones were smaller sized, more available and had many functions of a microcomputer. Tablets such as Microsoft Tablet PC, Wibrian B1 (Figure 1., Figure 2.)  
       - Were introduced and used in educational arrangements.  
       - Web 2.0 tools such as Facebook, Twitter, virtual learning environments such as Blackboard, Moodle were started to facilitate web based training of students.  
       - Apple introduced iPhone (Figure 5.) that has add-on computer capabilities as well as can use as an accelerometer, compass, navigation or camera, besides videophone system.  
       - Then similar devices were produced such as Motorola Xoom, Apple iPad (Figure 3., Figure 4.), Samsung Galaxy, Nokia Lumia (Figure 6., Figure 7.) etc. |
| 2010s | - "Internet of things" known as "machine to machine mobile connectivity" has  
       - Done virtual anything more intelligent.  
       - Mobile phones have been smarter, more available and had many functions of a personal computer and connected other mobile devices.  
       - Wearable technologies such as iWatch, Google Glass have been introduced and used in educational arrangements.  
       - With Web 3.0 tools known as semantic web, users have provided finding the right information in right time and in the right place.  
       - Mobile virtual reality has started to facilitate training of students, especially in medicine and marketing fields. |
With the speed of technological changes, mobile devices have been affecting cognitive and social processes continuously (Hamm, Drysdale & Moore, 2014). Ozan, Yamamoto and Demiray (2015) stated that mobile devices are important enablers of social structure and defined mobile learning as a learning process which occurs in mobile ecosystem that covers entertainment and games, web browsing and search, VOIP, voice, messaging, mobile TV, IP TV, mobile video, social networking and augmented reality applications.

On the other hand, Crompton (2014) defines mobile learning considering four central constructs such as pedagogy, technological devices, context and social interactions as follows:
“Learning across multiple contexts, through social and content interactions, using personal electronic devices (p. 8)”. Pedagogy has a key role in this process.

THE NEED FOR MOBILE PEDAGOGY

Mobile learning is a newly-emerging, unclear and immature field. The pedagogy of twenty-first century has occurred in education especially because of ubiquitous structure of mobile devices, therefore the research need to meet theories and apps right away. The pedagogy of twenty-first century has also in need of pedagogy for mobile learning by reasons such as saturation of market for mobile devices, access from worldwide to mobile devices, interest and habits of learners to technology, and supporting educational facilities. Hamm, Drysdale and Moore (2014) indicated some cases of pedagogy that have used in mobile devices are as follows:

- providing resources related the courses via mobile devices before the courses, it is seen as a strategy for reducing overload of the cognitive information to the memory of learners,
- learners can be use tablets for doing home works, looking course contents, interact with instructors, classmates, peers,
- ubiquitous usage of social networks support learning in such cases; online real-time participation to class, the participation of the course content and discussions as an extension of the learning management system, real-time participation to learning process by recording ongoing process, submitting any content, tracking of current events and assignments, interactive remote assignments,
- instructors can be record voicemails via apps so they provide feedback or announcement to learners,
- mobile games provide opportunity for engagement to learners.

As stated by Cochrane (2010), pedagogical affordances of mobile learning technologies provide the ability to engage in learning with conversations between students and lecturers, or student and peers, or students and subject experts, or students and social environments within any context. For this purpose, social media tools has been mostly using with mobile technologies such as Twitter, Facebook, Google+, LinkedIn as social networking, Diigo, Delicious as social bookmarking, YouTube, Vimeo, Skype, Flickr, Picasa as multimedia sharing, Google docs, Wikis, Slideshare as shared workspaces, Blogger, WordPress as blogs. Contextual parameters to characterize mobile learning against traditional approaches are shown in Table 2 (Pimmer, & Pachler, 2014).

According to the Govindasamy (2002), one of the most crucial prerequisites for successful implementation of e-learning is the need for careful consideration of the underlying pedagogy, or how learning takes place online (p. 287). E-learning, as well as distance learning, is in a similar tendency with mobile learning within the context of providing opportunity for learning independently from time and location. However, since mobile learning is a new field and there is such a little research in the field, more time is needed to identify and analyze the niceties different from distance learning or e-learning.
Otherwise, mobile learning is seen as a great opportunity for distance learning because of its content-oriented structure and its unique attribute for instant learning (Traxler, 2009). Besides, mobile learning is sometimes considered as a part of e-learning development or the transition from e-learning to mobile learning can be defined as the change of terminology.

**Table 2.**

**Contextual parameters to characterize mobile learning against traditional approaches**

<table>
<thead>
<tr>
<th>Contextual parameters</th>
<th>Traditional approaches</th>
<th>Enriched approaches with mobile learning</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Content</td>
<td>Delivering</td>
<td>Creating, sharing</td>
<td>Producing and sharing of digital materials such as audio, video, text, photo, slide etc.</td>
</tr>
<tr>
<td>Work-based processes</td>
<td>Learning for work</td>
<td>Learning for work, learning at work</td>
<td>Accessing of resources for immediate problem solving</td>
</tr>
<tr>
<td>Social form</td>
<td>Individual</td>
<td>Individual, social</td>
<td>Social mobile networking, creating networks and locating specialists</td>
</tr>
<tr>
<td>Formality</td>
<td>Formal setting</td>
<td>Formal or informal setting</td>
<td>Documenting of learning experiences (e.g. mobile portfolios) and debriefing in classroom or mentoring settings</td>
</tr>
<tr>
<td>Educational paradigm</td>
<td>Cognitive, behavioral</td>
<td>Socio-cognitive, situated, social, cultural constructivist, multimodal</td>
<td>Situated learning, reflective practices, spreading of innovations, ideas, peer-to-peer learning, active knowledge construction, becoming a member of a professional community</td>
</tr>
</tbody>
</table>

In point of fact, in the literature, the distinction is not entirely clear between mobile learning and e-learning, e.g. e-learning is defined as such statements; structured, enriched media content; interactive, multimedia, mobile learning is defined as spontaneous, personal, private, informal, situated, context-aware, mobile (Laouris & Eteokleous, 2005; Freysen, 2005). It can be said that e-learning is complied with paradigms of traditional environments, whereas mobile learning is required a pedagogy independent from time and location. Also, pedagogical principles of e-learning, as well as mobile learning, must take into account in learning environments to govern good practice of teaching.

**USING REVISED BLOOM’S TAXONOMY FOR MOBILE LEARNING**

Original Bloom’s Taxonomy, which is considered as a way of categorizing planned skills that are required in learning environments, was created by Benjamin Bloom in 1950s. Bloom’s taxonomy of learning identified three domains of learning activities: cognitive, affective and psychomotor. The cognitive domain can be used to illustrate mobile learning activities. It contains six main categories in cognitive areas such as knowledge, comprehension, application, analysis, synthesis and evaluation (Bloom, 1956; Bloom, 1976). With the revision of Anderson, Krathwohl and Bloom (2001), “knowledge” category changed with “remember” and all categories converted from noun forms to verb forms (e.g. Application become Apply).
Besides, “comprehension” category named “understand”, "synthesis" and "evaluation" categories are replaced, and also “create” category is placed to the top of taxonomy (Figure 8., Krathwohl & Anderson, 2010).

![Original Bloom Taxonomy and Revised Bloom Taxonomy](image)

**Figure 8:**
*Original Bloom Taxonomy and Revised Bloom Taxonomy (Krathwohl & Anderson, 2001)*

Revised Bloom’s Taxonomy is used to show a particular cognitive process in learning step by step (Krathwohl, 2002):

- **Remember:** Getting, identifying and calling to mind of relevant information by long-term memory.
- **Understand:** Identifying, interpreting, exemplifying, classifying, summarizing, comparing, and explaining the meaning of didactic messages that contains communication forms of speaking, writing and graphical.
- **Apply:** Using, implementing or applying appropriate method to a given situation.
- **Analyze:** Dividing materials into components and then uncovering, discriminating or organizing the relationships between each other, or between any component and the entire structure or goals.
- **Evaluate:** Making decision, checking or criticizing based on the standards or criterions.
- **Create:** Producing an original product, or creating an original, easily understood form of a whole by bringing components together.

Unlike the original Bloom’s Taxonomy, revised Bloom’s Taxonomy has two dimensions: knowledge and cognitive processes. It has merging knowledge dimension (factual, conceptual, procedural, meta-cognitive) with the cognitive process dimension (remember, understand, apply, analyze, evaluate, create) (Freyson, 2005; Krathwohl and Anderson, 2010; Fisher, 2011). Revised Bloom Taxonomy can be used to analyze the target of a syllabus or a unit, or to classify learning activities according to the learning objectives, or to be aware of the relationship between assessment and learning/teaching activities, or to examine the teaching materials (Amer, 2006).
From the constructivist, cognitive or even from a developmental perspective on learning, revised Bloom’s Taxonomy could be applied to the implementation of mobile learning in higher education (Freyssen, 2005:74). For example, revised Bloom Taxonomy could be used for designing mobile learning environments in meta-cognitive (learning to learn) knowledge level. Learning a fact, a concept, or a procedure that can be implied for an objective or an outcome can be measurable. Fisher (2011) has suggested using cognitive and knowledge dimension of Bloom’s Taxonomy in writing distance learning objectives with the sample verbs like in Table 3.

**Table 3.**
*Cognitive and knowledge dimension in Bloom’s Taxonomy (Fisher, 2011)*

<table>
<thead>
<tr>
<th>Bloom’s Taxonomy</th>
<th>Cognitive Process Dimension</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge Dimension</td>
<td>Remember</td>
</tr>
<tr>
<td>Factual Knowledge</td>
<td>List</td>
</tr>
<tr>
<td>Conceptual Knowledge</td>
<td>Describe</td>
</tr>
<tr>
<td>Procedural Knowledge</td>
<td>Tabulate</td>
</tr>
<tr>
<td>Meta-Cognitive Knowledge</td>
<td>Appropriate Use</td>
</tr>
</tbody>
</table>

According to Stone (2004), Bloom’s Taxonomy can make mobile learning activities more successful by providing repetition service on learned subjects, testing on learned material, giving just-in-time learning, providing background information, giving the user different information on the same subject, and giving tools that help the user to develop new documents or projects.

Apart from Bloom’s Taxonomy, there are alternative models that are using to evaluate cognitive processes of learning, such as SOLO (Structure of Observed Learning Outcomes) Taxonomy, Fink’s Taxonomy, and PI Model (Practical Inquiry Model of Cognitive Presence) (Schrire, 2004; Brabrand & Dahl, 2009; O'Neil & Murphy, 2010).

While Bloom’s Taxonomy has six levels from lower to higher, SOLO Taxonomy (developed by Biggs and Collis, 1982) has five hierarchical levels from incompetence to expertise (pre-structural, uni-structural, and multi-structural, relational, extended abstract). Otherwise, PI Model can be described as a spiral movement that consists of triggering event, exploration, integration and resolution (Akyol, Arbaugh, Cleveland-Innes, Garrison, Ice, Richardson, Swan, 2009). According to Schrire (2004), this model can be used in socio-cognitive processes, rather than individual cognitive processes. On the other hand, Fink (2003) presents a structured sequence self-directed guide to design the content of a course. He also proposes a taxonomy which consists of six categories such as foundational knowledge, application, integration, human dimensions, caring, and learning how to learn.
Like revised Bloom’s Taxonomy, Fink’s Taxonomy also focuses on students’ metacognitive knowledge level. Shea, Gozza-Cohen, Uzuner, Mehta, Valtcheva, Hayes and Vickers (2011) suggested SOLO to evaluate learning outcomes as reflected in student assignments related to online discussions by classifying them in such levels. Schrire (2004) claimed that PI Model (developed by Garrison, Anderson & Archer, 2001) is better than Bloom’s or SOLO taxonomies to analyze cognitive domain in knowledge-building processes.

Today, there are several mobile apps that are available mostly free and can be used for open and distance learning. Emerging tools and educational apps to support revised Bloom’s Taxonomy for mobile learning are shown in Figure 9 and then some of them are introduced briefly as follows:

**Figure 9:**
**Emerging tools and educational apps to support revised Bloom Taxonomy**

- **Blogger** provides students an opportunity to reflect and analyze course materials which created by educators or classmates ([https://www.blogger.com](https://www.blogger.com)),
- **The SoloLearn educational apps** use open video content from Youtube about topics such as programming, web design, photography ([http://www.sololearn.com](http://www.sololearn.com)),
- **Educreations** is a unique interactive whiteboard and screen casting tool. Instructional videos can be created and shared instantly,
- **Zoho Docs** is an online document management app that provides adding files, creating/editing documents, sharing files/folders, storing files offline,
- **Inspiration Maps™** is a visual learning app to build diagrams, graphic organizers and outlines,
- **Skype** provides video call, instant messaging, and voice calls for free. It is available on smartphones, tablets, PCs, Macs, and even some TVs and wearable devices,
✓ *Edmodo* is using for securing classroom discussions, posting assignments, gradebook tracking, and file sharing and uploading,
✓ *Splice* is a video editor for iOS to create videos and slideshows, with no length limits, watermarks, or ads,
✓ *VidTrim* is a video editor and organizer for Android. It includes multiple features like trimming, merging, frame grabbing, video effects, and transcoding (compress and convert to MP4), and share videos,
✓ *Wufoo* is a form designer that helps to create contact forms, online surveys and invitations so the data, registrations and payments can be collected ([http://www.wufoo.com](http://www.wufoo.com)).

**CONCLUSION AND RECOMMENDATIONS**
Mobile devices can be easily integrated into activities and materials in the learning environments such as collaborative learning, constructive learning and situated learning (Cole and Stanton, 2003; Ryu and Parsons, 2009; Herrington, Herrington, Mantel, Olney and Ferry, 2009b). However, the affordances provide by mobile learning could be clearly seen when the appropriate supporting systems or learning flow was established (Lai, Yang, Chen, Ho and Chan, 2007).

Besides, mobile learning have been reshaping the mobile apps and needs a different pedagogy (Frohberg, Göth and Schwabe, 2009; Herrington et al, 2009) in comparison with traditional approaches. In this study it has been also recommended to identify learning outcomes and learning objectives that supports convenient pedagogy for mobile learning while designing mobile learning apps.

Mobile learning apps are constantly evolving and can be also easily incorporated into any lesson. This study aims to inspire designers and educators to utilize mobile technology to take learning out into the world.

Mobile learning apps tends to provide knowledge and cognitive levels of thinking. Just because, revised Bloom Taxonomy aims to provide learning outcomes and learning objectives in these levels (Fisher, 2011; Yen, Lee, Chen, 2012). Today, many mobil apps structured in augmented reality can be easily placed on bulletin boards, newspapers, textbooks etc. They have also a wide spread over the world via social media, bookmarking, RSS, social networking, maps, and podcasting (Ozan et al., 2015). Besides, they can be structured as mass online courses according to individuals' interests (Kesim and Altnpulluk, 2014), hereby the content of courses which presented in higher quality to a larger number of learners will become one of the basic parameters in determination of educational policies in the future.

For this reason, framing learning objectives before building the detailed course content is a vital step and in this step Bloom’s Taxonomy offers an excellent tool to write effective learning objectives (Arshavskiy, 2016).

This paper recommends to use revised Bloom’s Taxonomy when building mobile apps for learning. However, variety of alternative models can also be used to design mobile apps for learning such as SOLO Taxonomy, Fink’s Taxonomy and PI Model. In future research, there is a need to compare different models before building learning content of mobile apps, and also open and distance learning courses.

**BIODATA and CONTACT ADDRESSES of AUTHORS**

Gülay EKREN has been working as a lecturer at the Department of Computer Technologies of Vocational School of Ayancık, Sinop University since 2009. She has a BA degree from the Computer and Instructional Technologies Department of Ege University, and MA degree from the Management Information Systems Department of Gazi University. She also has an online MA degree from the Distance Education Department of Anadolu University. She is now a PhD student in Department of Management and Information Systems in Sakarya University. Her research
interests are open and distance learning, distance education management, mobile learning, quality assurance and accreditation in open and distance learning, management and information systems.

Gülay EKREN
Sinop University,
Vocational School of Ayancık, Sinop, TURKEY
Phone: +90 368 613 3436 Extension: 6915
Email: gekren@sinop.edu.tr

Nilgün OZDAMAR KESKIN received her Ph.D. in Anadolu University Educational Sciences Institution, Department of Computer Education and Instructional Technologies in 2011. She served as a visiting researcher at University of Central Florida (2009-2010), and as a research assistant at Open Education Faculty, Anadolu University (2005-2012). She still continues to serve as an assistant of professor at Anadolu University. She is currently working as an executive coordinator of Photography and Cameraman Associate Degree Program, an E-portfolio System Coordinator of Public Service Practice Course for Preschool Teacher Training Program and an assistant of Erasmus Coordinator for Open Education Faculty. Also, she is managing an international project on mobile learning granted by British Council and several national projects. She got a best paper award at mLearn Conference 2011 in China. Her research interests include instructional design, open and distance education, online learning, mobile learning, and seamless learning design.

Nilgün OZDAMAR KESKIN
Anadolu University,
Open Education Faculty, Eskişehir, Turkey
Phone: +90 222 335 0580 Extention: 2463
Email: nozdamar@anadolu.edu.tr

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