Interactive mobile learning: a pilot study of a new approach for sport science and medical undergraduate students

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Bruce-Low SS, Burnet S, Arber K, Price D, Webster L, Stopforth M. Interactive mobile learning: a pilot study of a new approach for sport science and medical undergraduate students. Adv Physiol Educ 37: 292–297, 2013; doi:10.1152/advan.00004.2013.—Mobile learning has increasingly become interwoven into the fabric of learning and teaching in the United Kingdom higher education sector, and as technological issues become addressed, this phenomena has accelerated. The aim of the study was to examine whether learning using a mobile learning device (Samsung NC10 Netbook) loaded with interactive exercises promoted learning compared with a traditional library exercise. Using a randomized trial, 55 students from an undergraduate sports science course (n = 28) and medical course (n = 27) volunteered to participate in this study. A mixed-model design ANOVA was used to examine the percent change in test score after a 3-wk intervention. Results showed that there was a significant difference between the two courses (P < 0.001), methods (P = 0.01), and trials (P < 0.001). The findings suggested that both methods augmented student knowledge and understanding in sports science and medical students. The sports science group demonstrated proportionally greater increases in test performance when exposed to the mobile interactive intervention compared with the traditional library approach. Qualitative data suggest an increased level of engagement with the Netbooks due to the stimulating interactive content. In conclusion, the Netbooks were an effective additional learning tool, significantly enhancing knowledge and understanding in students. Further research should ensure that participants are assessed for preferred learning styles, the subjective task value of expectancy value, and readiness for mobile learning to ascertain if this has an effect on the potential for using mobile learning and interactivity.

IN AN ALREADY TECHNOLOGY-ENHANCED learning and teaching environment, mobile learning has become ever more interwoven into the fabric of the United Kingdom higher education sector. Students seek to search, access, and retrieve information continuously in a culture coined as “whatever, whenever, wherever” (23). The process of data retrieval and subsequent learning has been augmented as the technological hardware has decreased in size while the storage capacity has increased, making learning devices more portable within the “Mobile Age” (19).

The concept of mobile learning (m-learning) refers to the use of mobile devices to engage learners (19, 15). While an exact pedagogical definition remains elusive, it has been suggested that it intersects mobile computing with e-learning and combines individualized learning with anytime and anywhere learning (34). This is further contextualized with the suggestion that m-learning is a product of the mobility of the environment whereby learning occurs away from the learner’s typical learning environment (33). This was developed further with the suggestion that the learner is not in their usual or indeed fixed location but also that it is the use of a mobile learning device that defines the concept of m-learning (26). Research has attempted to consolidate these findings, with four principle definitions emerging (Table 1) (31). These definitions have found support (32), but the authors proposed less concise expressions than those shown in Table 1. Instead, m-learning is interpreted as a new education method helping individuals to acquire knowledge with the help of mobile technologies with learning occurring in a ubiquitous manner (20).

With this in mind, there appears to be an insurgence of literature purporting the use of different technologies within learning (24) through a considerable number of small scale trials and pilots (30). While some authors (19) have advocated the use of mobile technologies for distance learners, only limited evidence has been found for its application with the vast majority of the higher education students, with most students still preferring to use desktop personal computers to download media such as podcasts. In contrast, such media tend not to be transferred to mobile devices (e.g., mp3 players) for learning “on the go.” This view is supported by research (6) into the effectiveness of personal digital assistant technology on student learning and usability. The authors concluded that only 30% of the participants used the device on a daily basis and only one participant made use of the wireless network in another location other than the building in which the students studied. In a more recent study (27), it has been suggested that the existing technological solutions only partly meet educational and work-related needs in medical contexts, thus demonstrating the usefulness of the present study.

Despite equivocal findings regarding the use of mobile technology to facilitate learning, technology through a variety of interventions, including computer-based simulations, can be used successfully to aid student engagement (25). Results have demonstrated that student learning was improved through the implementation of interactive learning. While no quantitative measures of learning were analyzed, semistructured interviews provided evidence that the learners found the practical application (66% of the cohort) useful, whereas only 16% reported it “enjoyable” and only 18% reported motivation to learn about statistics as a result of this intervention. These findings agreed with findings from Utah State University that found that 54% of students surveyed regularly used mobile devices for accessing academic material (6). While discrepancies exist in the literature, research has found that comprehensive induction programs could potentially alleviate the reluctance of students to engage in using mobile devices for academic purposes (3).
Further potential reasons for learner engagement with m-learning are varied but include learners’ perceived self-efficacy, which, in turn, influences the approaches perceived ease of use. This is believed to be important for successful engagement with m-learning (13). This is also true of mobility (21), which is deemed as the most important factor to consider in successful learner engagement or at least the perceived mobility value that is key to engagement with this form of learning (12). Perceived enjoyment (28) and how much value an individual places on the task (the expectancy value theory) are both important factors that contribute to the success of m-learning (20). In association with this concept, research has observed that readiness for e-learning required the learners to be able to work autonomously and be comfortable with e-learning (29). This supports the concept (13) that self-efficacy influences the ease of use of alternative modes of learning. The multitude of factors that contribute to successful m-learning and their interaction are shown in Fig. 1.

While the previously stated technology needs to be “fit for purpose,” m-learning should not be focused exclusively on the gadgetry but rather on the desire and motivation to learn anytime and anywhere (17). In addition, effective learning needs to possess both informality and portability, with interactivity required to aim in the motivation process to learn and engage further (21). To address such challenges, research (9) suggests that three factors need to be considered when choosing or constructing teaching material. These include the need to correlate with the course content, accuracy in the presentation of the concept, and the ease with which the students access the material. Unfortunately, these issues are frequently not considered by teaching staff (18) or that too much time is spent learning how to use the course material (4).

The present study proposed to build on the success of using mobile devices through the unique use of interactive m-learning technology described as self-directed learning (1). An easy-to-use technology or deployment platform (4) hosted the interactive exercises based on the previously stipulated criteria (9) to ensure that the content was constructively aligned with the courses. In addition, practical issues that mobile devices have incurred previously, such as slow processing, small screens, limited storage capabilities (14, 22), and limited battery life (5) have been addressed through the use of the Samsung NC10 Netbook. The aim of the present study was to examine the use of m-learning technology in an interactive manner to help develop student knowledge and understanding of electrocardiography (ECG) technique and theory.

METHODS

Participants. Fifty-five undergraduate students (28 year 1 undergraduate sports science students and 27 year 1 undergraduate medical students) were invited to volunteer for the study. The inclusion criteria for the study required students who had not obtained ECG experience through either practical or theoretical sessions. There was no summative assessment grade attributed to this research to ensure there was no coercion of the participants. Volunteers were provided with a participant information sheet and given time to contemplate their inclusion in the study. Once they had agreed to volunteer, all participants provided informed consent. Ethical approval was obtained from the Centre for Health, Exercise and Sport Science Ethics Committee of Southampton Solent University.

Testing. Initially, all participants were given a 28-question, short-answer test on a topic they had not previously completed (ECG). Test questions were derived from a year 2 medical degree course assessment. As part of the university’s assessment regulations, the questions were peer reviewed by a subject specialist who was not part of the research team. The examination was undertaken as an unseen, closed-book invigilated assessment. Participants were not briefed on the topic before undertaking the test, although they were told it would be a topic they would at some stage cover during their undergraduate studies. On completion of the test, all marks were collated. Participants were randomly allocated to one of two groups. The first group was a library-based group who were provided with a list of key textbooks chosen to assist the participants in revising for the posttest. The second group were provided with a Samsung NC10 Netbook (Samsung, Beijing, China). The device elicits an acceptable processing speed through a 1.6-GHz Intel Atom N270 processor, a screen measuring 10.2 in. with a resolution of 1,024 × 600 pixels, and a battery life of up to 7 h. The Netbook was loaded with a video detailing the ECG technique incorporating multiple-choice questions and interactive exercises. The interactivity included click and drag exercises, where students were, e.g., required to click and drag electrodes from the side of the screen onto a screen shot of a human torso and place them in the correct location. Correct placement resulted in a green tick, and incorrect placement resulted in a red cross. Each group was given 3 wk to learn the associated techniques and theory underpinning the ECG procedures and were then retested using a different battery of 28 short-answer questions to allow a pre- and postassessment to monitor participant engagement with the task (2). All 55 students completed the posttest.

To ensure that no student was disadvantaged, the library group was provided with the opportunity of using the NC10 Netbooks after the posttest data had been collected. In contrast, participants in the Netbook group were provided with the reading list.

Focus groups. A small sample of students (n = 7) volunteered to participate in a focus group to explore students’ views on the different modes of learning. The sample consisted of students representing both library and Netbook groups from both institutions. The aim of the focus group was to encourage participants to discuss their experiences of the study mode, to examine the potential advantages and disadvantages of the differing approaches. The focus group discussion was recorded, and detailed notes were taken. Responses were analysed for content and combined to ascertain common themes.

Fig. 1. Adaptation (20) showing the interaction between potential reasons behind the success/failure of mobile learning (m-learning) based on learner adoption of the learning approach.

Table 1. Definitions of mobile learning

<table>
<thead>
<tr>
<th>Definition</th>
<th>Description</th>
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<tbody>
<tr>
<td>Definition 1</td>
<td>Enabling the possibility of lifelong learning through being learner centered</td>
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<tr>
<td>Definition 2</td>
<td>Defined by being an extension of e-learning</td>
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<tr>
<td>Definition 3</td>
<td>Learning that makes use of mobile devices (technocentric)</td>
</tr>
<tr>
<td>Definition 4</td>
<td>Augmenting formal learning</td>
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</tbody>
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Definitions were taken from Ref. 31.
How We Teach

Statistical analysis. A mixed-model ANOVA (course \times method of learning \times test result) with a simple contrast was used to analyse the main between-group, within-group, and interaction effects of the test results. Statistical significance was set at \( P < 0.05 \) (by a two-tailed test). Results were analyzed using SPSS version 20 (IBM, Armonk, NY) and presented in accordance with Drummond and Vowler (7).

RESULTS

A total of 55 undergraduate students from undergraduate medical degree (\( n = 27 \)) and undergraduate sports science degree (\( n = 28 \)) programs volunteered to participate in this study. After the completion of an ECG-themed test, volunteers were randomized into either a Netbook (\( n = 27 \)) or library group (\( n = 28 \)) and instructed to learn the ECG technique and accompanying theory accordingly during a 3-wk period, after which a similar test was readministered. Test results are reported as between-group effects (i.e., differences between courses and differences between methods of study), within-group effects (i.e., pre- and posttest difference), and interaction effects (i.e., combined between- and within-test effects). The findings are shown in Table 2 and Fig. 2.

Course effects. Overall test scores (i.e., combined pre- and posttest scores for each course) were, on average, 291% higher in medical students who completed the test [49.7 (25.3)%] compared with sports science students [12.7 (14.5)%]. This resulted in significant main between-course effects \( F_{(1,51)} = 233.67, P < 0.001, \eta_p^2 = 0.93 \).

Method of study effects. Main significant effects between the methods of learning (i.e., combined pre- and posttest scores for each method) were found, with those learning using the Netbook achieving an average score 21% higher [33.8 (30.0)%] compared with those using the library method [27.9 (25.0)%]; \( F_{(1,51)} = 7.24, P = 0.01, \eta_p^2 = 0.124 \).

Pre- and posttest effects. Significant within-group effects for the pre- and posttest scores were found, with the average test score increasing by 183% between the pretest [16.1 (14.0)%] and posttest [45.5 (30.1)%]; \( F_{(1,51)} = 201.76, P < 0.001, \eta_p^2 = 0.80 \). Further analysis using a simple contrast found significant test effects within both courses (\( P < 0.001 \)) regardless of the method of learning. However, the sports science group demonstrated a significant 115% difference in test result (\( P = 0.012 \)) between the posttest Netbook group [8.0 (5.6)%] and library group [3.7 (2.0)%]. In contrast, no significant learning difference was observed between the two methods in the medical group (\( P = 0.23 \)).

Interaction effects. Significant main interaction effects were found between course \times test \( F_{(1,51)} = 40.28, P < 0.001, \eta_p^2 = 0.44 \) and method of learning \times test \( F_{(1,51)} = 13.0, P = 0.001, \eta_p^2 = 0.203 \). No significant differences were found when test \times course \times method of learning interacted or when the course \times method of learning interacted.

Focus group findings. Overall, sports science students expressed a preference for using the Netbooks for learning as it enabled a more successful intake of information due to the use of audio visual material as well as activities. The animated material held the learners’ attention and maintained their interest, resulting in an inclination to persist with learning. The use of quizzes was particularly enjoyed, as it enabled students to gauge their level of understanding. This was in contrast to the library group, who felt that the use of books was boring and tedious and believed that they suffered from a lack of skill in terms of collating information from different sources.

Conversely, medical students expressed no clear preference for either mode of learning and commented how they enjoyed reading a variety of books to gain different perspectives on the information.

Despite the sports science students’ clear preference for the use of Netbooks, students in the Netbook group from both institutions acknowledged that they often supplemented their learning by reading textbooks due to the familiarity of this traditional form of learning.

DISCUSSION

The aim of the study was to examine the use of m-learning technology in an interactive manner to help develop student knowledge and understanding of ECG technique and theory. In physiology, as with many of the physical sciences, sound theoretical understanding and practical application are essential attributes for successful study in higher education. To facilitate the required knowledge and understanding, university teaching staff have recently looked to exploit the technological experiences of undergraduate students by integrating education technology into the curriculum (35). However, with the numerous education technologies available, it is often difficult to determine those that are most likely to foster an effective learning environment (9). In particular, m-learning technologies traditionally possessed slow processing, small screens, limited storage capabilities (14, 22), and limited battery life (5). In contrast, the development and commercial availability of the Samsung NC10 Netbook has meant that many of the previous limitations have been addressed, allowing for an interactive ECG themed learning package to be produced.

Key study findings suggested that the ECG knowledge of all students assessed via a short-answer test increased after either the Netbook or traditional library interventions. However, students who used the NC10 device significantly outscored those in the library group (\( P = 0.01 \)) by 21%. This effect was felt to a greater extent in the sports science group, where the mean test score increased by 560% compared with the medical group, which increased by 292%. It should be stressed, however, that there was a significant difference (\( P < 0.001 \)) in test score between the two courses.

Course differences may be a product of differences in University and Colleges Admissions Service (UCAS) entry points (typical entry requirements to the medical university is 360 or above UCAS points, as opposed to the sports science university at 260–280 points). It could be hypothesized that

| Table 2. Pre- and posttest scores from the Netbook and library teaching interventions |
|-----------------------------------|-----------------|-----------------|
| **Pretest Score** | **Posttest Score** |
| Sports science students | | |
| Netbook group | 5.4 (4.1) | 28.6 (19.9)†‡ |
| Library group | 3.6 (3.6) | 13.3 (7.1)†‡ |
| Medical students | | |
| Netbook group | 26.3 (10.9) | 77.6 (17.1)* |
| Library group | 30.1 (8.2) | 64.8 (13.5)* |

Values (in %) are means (SD). †Significant difference between pre- and posttest scores; ‡significant difference between Netbook and library group scores.
learning a new topic for those students who are academically very able meant that the magnitude of the effect of the mode of learning is attenuated. In contrast, for students who are less academically able, the impact of interactive m-learning may have yielded greater effects, resulting in the significant differences between the student groups. Interestingly, the qualitative data supported this contention, suggesting that medical students engaged equally in both modes of learning, whereas sports science students persisted more with learning when using the Netbooks but struggled to collate information from various library sources. Research into the predictors of university academic successes have reported that the most effective predictor of academic success was high school grade point average and, to a lesser extent, student self-efficacy (16). The known entry requirement difference between the two institutions examined in the present study may suggest that the effect of the mobile interactive approach may have been attenuated through differences in academic ability.

Further examination of the participants showed that a small proportion of the medical students had previously completed a separate undergraduate degree (although none reported having undertaken ECG training). It may be hypothesised that these students have gained previous information literacy skills (not tested in the present study) from their former degree, resulting in a higher score in the test compared with those who have not completed an undergraduate degree.

An alternative explanation for the differences in success of the interactive mobile learning between the institutions may be explained through subjective task value of expectancy value theory (20). The theory suggests that the behavior relating to achievement can be predicted by two themes: what success is expected in a given task and the value the individual under-
taking the task places on the outcome. It could be interpreted that the differences between the groups may have been attributed to medical students perceiving the value of the task to be higher than that of the sports science group. Since ECG is an integral part of a medical student’s career (it is now a core topic where students have to declare their competence in the area of ECG before applying for employment), successful interpretation of this method can be the difference between life and death. In contrast, a sport science student is less likely to be placed in this situation and, as such, may have placed much less value on the success of the task.

Interestingly, it has been suggested that m-learning allows those who would not normally access the information to do so (1). It could be argued that the students studying sports science would not necessarily have accessed information on ECG, but having the mobile device with interactivity allowed them to access this knowledge they would not normally have, compared with library books. This may also help to explain the possible reasons for the significant increases in scores for the Netbook group compared with the library group. In addition, medical students may have had access to ad hoc learning opportunities through on-ward experiences that were completely unplanned, whereas sport science students would not have had this opportunity.

Conclusions. The present study has shown that the use of interactive m-learning can significantly improve students’ knowledge of a given topic compared with a traditional library exercise. The Netbooks were used as an additional learning tool, whereby the interactivity prompted student engagement. However, the concept of m-learning and the mobile nature of the device appear not to have added to the learning process. It is unclear where learning took place, although the additional use of textbooks, as mentioned by several of the Netbook group, would suggest that learning took place in typical learning environments. While significant differences were found between the two courses, this could be attributed to both the level of academic ability, information literacy experience, and the perceived importance of the topic.

Future research should investigate the implication of using this form of technology with students with varying degrees of academic ability and/or learning style preferences as well as controlling for ad hoc learning experiences to ascertain who is most likely to benefit most positively from this learning approach. Furthermore, a more indepth exploration of where m-learning is conducted and how this affects engagement would be particularly pertinent.

DISCLOSURES

No conflicts of interest, financial or otherwise, are declared by the author(s).

AUTHOR CONTRIBUTIONS


REFERENCES


