Original Research
Web-Based Versus Conventional Training for Medical Students on Infant Gross Motor Screening

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Abstract

Background: Early detection of developmental abnormalities is important for early intervention. A simple screening method is needed for use by general practitioners, as is an effective and efficient training method. This study aims to evaluate the effectiveness, acceptability, and usability of Web-based training for medical students on a simple gross motor screening method in infants. Materials and Methods: Fifth-year medical students at University of Indonesia in Jakarta were randomized into two groups. A Web-based training group received online video modules, discussions, and assessments (at www.school.org). A conventional training group received a 1-day live training using the same module. Both groups completed identical pre- and posttests and the User Satisfaction Questionnaire (USQ). The Web-based group also completed the System Usability Scale (SUS). The module was based on a gross motor screening method used in the World Health Organization Multicentre Growth Reference Study. Results: There were 39 and 32 subjects in the Web-based and conventional groups, respectively. Mean pretest versus posttest scores (correct answers out of 20) were 9.05 versus 16.95 ($p=0.0001$) in the Web-based group and 9.31 versus 16.88 ($p=0.0001$) in the conventional group. Mean difference between pre- and posttest scores did not differ significantly between the Web-based and conventional groups (mean [standard deviation], 7.56 [3.252] versus 7.90 [5.170]; $p=0.741$). Both training methods were acceptable based on USQ scores. Based on SUS scores, the Web-based training had good usability. Conclusions: Web-based training is an effective, efficient, and acceptable training method for medical students on simple infant gross motor screening and is as effective as conventional training.

Key words: medical education, distance learning, computer-assisted instruction, Internet, child development disorders

Introduction

Early detection of developmental abnormalities in infants is essential to ensure that intervention can be done as early as possible. However, early detection rates are unsatisfactory even in developed countries. In the United States, in 2005 only 50% of parents reported having had developmental evaluation performed on their children, and only 20–30% of children with a developmental disorder were diagnosed before reaching school age.1 This shows that the detection of developmental problems remains a challenge to primary care physicians. Initial recognition of disordered development is a competence that should be mastered by general practitioners, as they are often the first-line healthcare practitioners seen by infants and their parents.

The attainment of gross motor milestones is among the earliest events in an infant’s development and is the foundation for independent erect locomotion unique to humans as a species. Moreover, delayed gross motor development is often the first sign of global developmental delay.2 For these reasons, early detection of delayed or disordered gross motor development is of highest importance and should be carried out at the forefront of primary medical care.

One of the impediments to performing developmental assessment in primary care practice is that existing screening instruments are often perceived as time consuming, so that this part of the well-child visit is often skipped in busy, high-volume practice settings. Based on the World Health Organization Child Growth (WHO) Reference Standards Study,3,4 we offer a simple alternative screening method that does not require special equipment.

In the past decade, e-learning has become an increasingly attractive means of information and education. The effectiveness of the e-learning method in health and medical education has been demonstrated in several studies in developed countries.5–8 However, in developed countries such studies are scarce, and the feasibility of such online-based training methods remains questionable. In a geographically dispersed country such as Indonesia, e-learning holds the promise of
alleviating the costly travel expenses needed for live conventional training. In this study, we aimed to determine the effectiveness of Web-based training, compared with a conventional training, on a method for the early detection of gross motor development in infants, as well as to evaluate user satisfaction and usability of a Web training program.

Materials and Methods

Our study used a two-group pre- and posttest design with randomization. We recruited medical students in the fifth year of their studies and fresh graduates from the University of Indonesia Medical School, who gave written consent to participate in the study. Subjects were randomized using a computer-generated random number table into two groups. The experimental group attended a Web-based training course on infant gross motor development screening, and the control group received the same training module in a conventional live teaching course. Subjects were excluded if they did not have Internet access or were unable to complete the training.

Prior to commencement of the training courses, we developed a teaching module based on the gross motor screening method used by the WHO in their Motor Development Study held as part of the Multicentre Growth Reference Study.3,4 The module consisted of 10 chapters: introduction, recording method, sitting without support, hands-and-knees crawling, standing with assistance, standing alone, walking with assistance, walking alone, what to do when encountering delayed gross motor development, and neurological disorders associated with delayed gross motor development. Training videos were developed using well-child models and patients with relevant neurological disorders frequently encountered in daily practice, such as cerebral palsy and hypotonia. We obtained prior written parental informed consent for all models and patients used in the training videos. We also developed a 20-item assessment test to be administered before the training as a pretest and after as a posttest. For the Web-based training, the module was made accessible on the www.schoology.com Web site, an e-learning social media site, with the access code XSRJM-ZM25C. The training module and the Web-based training system were first tested by a group of students and residents, and necessary revisions were made to the module before it was administered to the study subjects.

Subjects in the experimental group were given 2 weeks to complete the Web-based course. Detailed instructions on how to use the Web-based interface were given by e-mail. Subjects were required to complete the preceding chapter and contribute to the discussion forum of each chapter before moving on to the next. The control group attended a 1-day, 8-h live training course. The same facilitators taught the Web-based as well as the live course using the same slides, and the same videos were used to demonstrate screening tests to both groups. To evaluate the effectiveness of the training module, subjects were asked to complete a 20-item multiple-choice test before (pretest) and after (posttest) the training. The same pre- and posttests were administered to the experimental and control groups. Scores were expressed as the number of correct answers out of 20. To evaluate the effectiveness of the respective training methods, we compared mean pre- and posttest scores within each group using the paired t test. We also compared mean posttest scores and mean pre- to posttest score difference between the two groups using the t test for two independent samples.

To assess user satisfaction with the training module, subjects in both groups were asked to complete a questionnaire modified from the User Satisfaction Questionnaire (USQ) developed by Kobak et al.6 We used 10 out of the original 15 USQ items. The items were scored on a scale from 1 to 4, with 1 being “strongly disagree” and 4 being “strongly agree.” The total score was computed as the sum of the item scores. A total score of 30 or more indicated that the participant found the module satisfactory and acceptable.

Usability of the Web-based training system was rated using the System Usability Scale (SUS) developed by Brooke10 and expanded by Bangor et al.11 The scale consisted of 10 multiple-choice questions scored on a scale of 1 (“strongly disagree”) to 5 (“strongly agree”). The total score was calculated according to the protocol by Brooke.10 The system was considered acceptable when the total score was 71 or more. In addition, subjects were asked to rate their overall learning experience on an adjective rating scale ranging from “worst imaginable,” “awful,” “poor,” “OK,” “good,” and “excellent” to “best imaginable.”

The study protocol was approved by the Medical Research Ethics Committee of the University of Indonesia in Jakarta.

Results

We recruited 75 subjects, of whom 39 were randomized into the experimental group and 36 into the control group. Four subjects from the control group crossed over to the experimental group due to scheduling conflicts. Four subjects in the experimental group dropped out of the Web-based training: 3 had accessed but did not complete the module, and 1 failed to access the module entirely. All subjects remaining in the control group completed the live training course. The final numbers of subjects analyzed in the experimental group and control group were 39 and 32, respectively (Fig. 1). Subject characteristics were comparable between the two groups (Table 1).

Pretest scores in the Web-based training group ranged from 0 to 19, whereas posttest scores ranged from 8 to 20. Mean pretest score was 9.05 (standard deviation [SD] 4.455), and
The mean posttest score was 16.95 (SD 3.178). Pre- to posttest score increase ranged from -3 to 12 points. Mean difference between pre- and posttest was 7.90 points (SD 5.170), yielding a 87% mean score increase ($p = 0.0001$). A score increase of 25% (5 points) or more was obtained by 24/39 (57.1%) subjects.

In the control group, pretest and posttest scores ranged from 5 to 13 and 10 to 20, respectively. Pre- to posttest score increase ranged from -1 to 18 points. Mean pretest and posttest scores were 9.31 (SD 2.402) and 16.88 (SD 2.575), respectively. Mean difference between pre- and posttest scores was 7.56 points (SD 2.575), or a 81% increase from pretest scores ($p = 0.0001$). Twenty-eight of the 39 (87.5%) subjects achieved a pre- to posttest score increase of 25% or more.

On independent $t$ test, there was no significant difference in mean pre- to posttest score increase ($p = 0.741$) or mean posttest scores ($p = 0.914$) between the experimental and control groups. Comparison of assessment results between the two groups is shown in Figure 2.

The combined mean USQ score of both groups was 3.25 (SD 0.32). Mean USQ score was 3.24 (SD 0.34) and 3.25 (SD 0.30) in the Web-based and conventional training groups, respectively. In the Web-based group, of the 28 subjects who completed the USQ, 33 (78.6%) rated the course with a total score of 30 or more, indicating that participants found the module to be satisfactory and acceptable. Of the 32 subjects in the control group, 27 (84.4%) rated the module as satisfactory. Details of subjects’ responses to each individual USQ item can be seen in Table 2.

The SUS questionnaire was administered only to the Web-based training group. Mean SUS score was 71.38 (SD 9.75), indicating that, on average, subjects found the Web-based learning system acceptable. On the adjective rating scale, 5/38 (13.2%) rated the system as “OK,” whereas 14/38 (36.8%) and 19/38 (50%) rated it as “good” and “excellent,” respectively. Student ratings for individual SUS items can be seen in Table 3.

**Discussion**

The present study compared the effectiveness of Web-based training with conventional live training for medical students and recently graduated general practitioners in the early detection of gross motor development abnormalities in infants. Our findings showed no difference between Web-based training and conventional training in posttest scores and pre- to posttest score increase. To the best of our knowledge, this is the first study comparing online e-learning with conventional learning in medicine in Indonesia. Most earlier studies on this topic have focused on other regions.

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**Table 1. Subject Characteristics**

<table>
<thead>
<tr>
<th>Sex</th>
<th>WEB-BASED GROUP ($N = 39$)</th>
<th>CONVENTIONAL GROUP ($N = 32$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>18 (42.9%)</td>
<td>13 (40.6%)</td>
</tr>
<tr>
<td>Female</td>
<td>24 (57.1%)</td>
<td>19 (59.4%)</td>
</tr>
<tr>
<td>Mean (SD) age (years)</td>
<td>23.37 (0.54)</td>
<td>23.30 (0.64)</td>
</tr>
<tr>
<td>Stage of medical training</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student</td>
<td>37 (94.9%)</td>
<td>32 (100%)</td>
</tr>
<tr>
<td>Recent graduate</td>
<td>2 (5.1%)</td>
<td>0 (0%)</td>
</tr>
</tbody>
</table>

SD, standard deviation.
topic were done in developed countries, and only few used a pre- and posttest design with a comparison group and randomization.12,13 Through our study design, we were able to show that Web-based learning was as effective as conventional learning in increasing participants’ knowledge.

In this study we have developed, applied, and evaluated a Web-based training module. Our experience in developing this module and finding a suitable online delivery system provides valuable input for future efforts to develop online teaching modules.

One of the obstacles encountered during the implementation of the Web-based training was difficulty for some subjects in obtaining affordable Internet access of sufficient speed to access the video contents of the module. We solved the problem by providing a modem at a fixed time and location, which the subjects could use to access the training module. A similar problem was faced by Moazami et al.14 in Iran, which was remedied by using an intranet. However, these solutions required participants to be present in the same space, thereby defying the very principle of e-learning and eliminating one of its advantages.

### Table 2. User Satisfaction Questionnaire Rating

<table>
<thead>
<tr>
<th>ITEM</th>
<th>WEB (N=38)</th>
<th>CONVENTIONAL (N=32)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The objectives of the training were clear.</td>
<td>0 0 23 (60.5) 15 (39.5)</td>
<td>1 (3.1) 0 17 (53.1) 14 (43.8)</td>
</tr>
<tr>
<td>2. The training was well organized.</td>
<td>1 (2.6) 0 26 (68.4) 11 (28.9)</td>
<td>0 0 27 (84.4) 5 (15.6)</td>
</tr>
<tr>
<td>3. The material was presented in an interesting manner.</td>
<td>1 (2.6) 0 23 (60.5) 14 (36.8)</td>
<td>1 (3.1) 0 20 (62.5) 11 (34.4)</td>
</tr>
<tr>
<td>4. There were sufficient examples, videos, and illustrations.</td>
<td>1 (2.6) 0 23 (60.5) 14 (36.8)</td>
<td>0 0 16 (50.0) 16 (50.0)</td>
</tr>
<tr>
<td>5. Concepts were clearly presented and easy to understand.</td>
<td>1 (2.6) 0 26 (68.4) 11 (28.9)</td>
<td>0 0 21 (65.6) 11 (34.4)</td>
</tr>
<tr>
<td>6. The length of the training was appropriate.</td>
<td>2 (5.3) 1 (2.6) 31 (81.6) 4 (10.5)</td>
<td>0 1 (3.1) 26 (81.3) 5 (15.6)</td>
</tr>
<tr>
<td>7. The training increased my knowledge and skill.</td>
<td>0 0 20 (52.6) 18 (47.4)</td>
<td>0 0 14 (43.8) 18 (56.3)</td>
</tr>
<tr>
<td>8. I feel capable of applying the material to my patients.</td>
<td>0 0 32 (84.2) 6 (15.8) 3 (9.4)</td>
<td>0 23 (71.9) 6 (18.8)</td>
</tr>
<tr>
<td>9. Web delivery is as effective as traditional teaching methods in helping me learn the material.</td>
<td>0 3 (7.9) 30 (78.9) 5 (13.2) 10 (31.3) 19 (59.4) 3 (9.4)</td>
<td></td>
</tr>
<tr>
<td>10. Overall, I was satisfied with the training and will recommend it to others.</td>
<td>0 0 27 (71.1) 11 (28.9)</td>
<td>0 0 25 (78.1) 7 (21.9)</td>
</tr>
</tbody>
</table>

The questionnaire was modified from Kobak et al.6 Responses were graded on a scale of 1 = strongly disagree, 2 = disagree, 3 = agree, and 4 = strongly agree. Data are n (%).

### Table 3. System Usability Scale Rating

| ITEM                                                                 | 1 2 3 4 5 |
|---------------------------------------------------------------------|------------|-----------|-----------|-----------|-----------|
| 1. I think I would like to use such a learning system frequently.   | 0 1 (2.6) 9 (23.7) 23 (60.5) 5 (11.9) |
| 2. I found the system unnecessarily complex.                        | 4 (10.5) 26 (68.4) 5 (13.2) 3 (7.9) 0 |
| 3. I thought the Web-based learning system was easy to use.         | 0 2 (5.3) 0 27 (71.1) 9 (23.7) |
| 4. I think I need the support of a technical person to be able to use this system. | 4 (10.5) 23 (60.5) 3 (7.9) 8 (21.1) 0 |
| 5. I found the various functions in the system were well integrated | 0 0 1 (2.6) 32 (84.2) 5 (13.2) |
| 6. I thought there was too much inconsistency in this system.       | 1 (2.6) 34 (89.5) 2 (5.3) 1 (2.6) 0 |
| 7. I imagine most people would learn to use this system very quickly. | 0 2 (5.3) 8 (21.1) 23 (60.5) 5 (13.2) |
| 8. I found the system very awkward to use.                          | 9 (23.7) 24 (63.2) 4 (10.5) 1 (2.6) 0 |
| 9. I felt very confident using the system.                          | 1 (2.6) 1 (2.6) 2 (5.3) 29 (76.3) 5 (13.2) |
| 10. I needed to learn a lot of things before I could get going with this system. | 2 (5.3) 19 (50.0) 5 (13.2) 12 (31.6) 0 |

The questionnaire was modified from Brooke.10 Responses were graded on a scale of 1 = strongly disagree to 5 = strongly agree. Data are n (%).
advantages (i.e., the possibility for participants to learn at a time and place most suitable for their individual needs and preferences).

Four subjects who had been randomized into the conventional training group crossed over to the Web-based training group due to conflicts between the live training schedule and their on-call duty. No subject who was randomized into the Web-based group requested to cross over to the conventional training group. This delineates time flexibility as one of the main advantages of e-learning.

Only two recently graduated general practitioners participated in our study. Such general practitioners are typically undergoing internship in remote areas, which raised the difficulty of finding a suitable time to assemble them for live training. A Web-based training could be the solution to this problem; however, finding an adequate Internet connection in their regions of duty was equally problematic.

We evaluated the effectiveness of the training programs by administering pre- and posttests consisting of multiple-choice questions. Although the learning objective was the acquisition of a skill set, we did not directly assess the participants' skills due to difficulties finding a sufficient number of patients for a hands-on assessment. However, previous studies have shown that knowledge is positively correlated with clinical performance. Multiple-choice question assessment scores predict objective structured clinical examination scores, which in turn is a strong predictor of clinical performance. Based on these considerations, we hope the positive changes in subjects' knowledge will translate into improved clinical competence.

As our main outcome measure, posttest scores were significantly higher than pretest scores in both the Web-based and conventional training groups. Both groups were similar in their baseline abilities, as indicated by the similar mean pretest scores. This shows that the module was effective in increasing the participants' knowledge. The mean difference between pretest and posttest scores, as well as the mean posttest scores, was similar in both groups, indicating that live conventional training and Web-based training did not differ in their effectiveness. The same facilitators who developed the training module taught the live and the Web-based training, and the same slides and video illustrations were used in both training methods. These factors might have contributed to the similarity in parameters of effectiveness in both groups. The effectiveness of the e-learning methods has been previously demonstrated in several other studies, with a knowledge increase of 46–69%. In the present study, we obtained a mean increase of 87% from baseline score in the Web-based training group. We did not measure long-term knowledge retention in our study, but Moazami et al. have demonstrated that assessment scores 2 months after course administration did not differ significantly from the original posttest scores.

In a previous study comparing game-based e-learning with traditional learning, e-learning was found to be more effective in the subject of anatomy compared with physiology. This suggests that e-learning tends to be more effective for topics that are visually loaded, whereas traditional learning is superior in concept-heavy topics. The subject taught in our study was developmental screening in infants, for which illustrations and demonstrations are instrumental. Our module therefore benefits from an e-learning model.

In the current study, we also measured subject satisfaction with the contents of the training module using the USQ. Mean total USQ score was >30 in both groups, indicating that subjects were generally satisfied with the module. Eighty-seven percent of all participants gave a total USQ score of 30 or more. We found it important that all subjects agreed that the training increased their knowledge and skill. In the Web-based training group, all subjects felt capable of applying the material to their patient. It is interesting that in the conventional training group 3 subjects (9.4%) did not feel capable of applying the learned material. The conventional training group had access to the facilitators only during the 8-h live training session, whereas the Web-based training group were able to connect with facilitators through the online discussion forum for 2 weeks, which allowed them to process what they have learned and to ask better questions. This may be a contributing factor to subjects' perception of their capability in applying the training material. In a systematic review, Salter et al. similarly reported that students who had undergone an e-learning course experienced a significant increase in self-confidence after having completed the course.

In the Web-based training group, 92.1% of subjects believed that Web delivery is as effective as conventional learning. In a systematic review, Salter et al. reported that in most studies e-learning was perceived as acceptable, relevant, and practical. In another study by Nesterowicz et al., 217/236 (92%) subjects agreed that e-learning was effective, with the topic of the course being the most important aspect.

Of all participants, 13 (19%) disagreed that Web-based delivery is as effective as traditional teaching methods. We found it interesting that such a perception was more prevalent in the conventional training group (31.3%) than in the Web-based training group (7.9%). Because the questionnaire was administered after subjects had completed the training, it appears that undergoing the Web-based training convinced most subjects in this group on the effectiveness of the online teaching vehicle. However, the effect of Web-based learning itself in changing students' perception of the effectiveness of e-learning was not measured in this study.
Four students dropped out of the Web-based training, whereas all students who participated in the live training completed the course. In a similar study by Mehrdad et al.,¹² students felt that the physical presence of a teacher in traditional learning made them feel more motivated and more connected with teachers as well as with peers, resulting in a higher participation rate than in e-learning.

Evaluation of the usability of the Web-based learning system using the SUS questionnaire showed that subjects found the system useful and acceptable. The main difficulties subjects faced when using the system were the perceived need for technical assistance (21%) and the need to learn a lot of things before they were able to use the system (31.6%). A small proportion of subjects (7.9%) thought the system was too complex. One way to help students overcome technical issues is to conduct a special training session on using the system, but if such a training session involves assembling participants for an in-person meeting, it would again defy the principles and advantages of online learning. Despite these issues, however, most subjects (86.8%) rated the system as “good” or “excellent” in the overall adjective rating scale.

Web-based training is effective in teaching medical students and general practitioners on gross motor screening in infants and does not differ in effectiveness from conventional live training. Medical students and general practitioners consider the Web-based training system satisfactory and acceptable as a learning method. For a minority of students, technical issues still hamper the usability of the Web-based system. A Web-based learning system can become a solution to extend the reach of continuing education in medicine and healthcare, providing an adequate Internet connection is available. Further studies are needed to explore the long-term retention of knowledge and competences acquired using an online learning system. An evaluation system should be developed to measure skills within an e-learning model.

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REFERENCES

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