The incorporation of hands-on tasks in an online course: an analysis of a blended learning environment

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This article describes the design and evaluation of a blended online/face-to-face course completed by more than 6000 learners throughout the United States of America and internationally. The educational impact was monitored using a variety of evaluation strategies. The results, in terms of achieved knowledge and overall satisfaction, indicate that a focus on online instruction combined with face-to-face, hands-on activities showed statistically significant improvement in the learners’ understanding of the course material, while also validating the impact of the curriculum in their workplace. As illustrated through the blended course design, this study further showed that online learners with greater improvement in their pre- and posttest scores also exhibited significantly greater likelihood in demonstrating competency in several areas during the hands-on portion of the course. In particular, participants working in the information systems field exhibited the highest mean difference score (21.49) on the pre- and the posttests, while those working in the laboratory had the lowest (12.17). Likewise, the odds that participants who reviewed the course contents sought to further understand their job roles was 58.2 times greater for those in information systems, while it was only 19.0 times greater for laboratory staff, than those who did not review their job roles.

Keywords: blended learning; online learning; competency; constructivism

Introduction

Since the late 1990s, there have been numerous efforts to incorporate distance learning content into pedagogical initiatives (Garrison and Kanuka, 2004; Weiss, Knowlton, \& Speck, 2000). Such efforts have often been well received, primarily because online instruction has been considered to be a cost-effective way for improving learning outcomes (Gabriel, 2011; Hiltz \& Turoff, 2002). The inclusion of virtual content allows participants to practice tasks asynchronously at their own pace, while also receiving immediate feedback which is often constructive as well as personalized. Likewise, online instruction can be highly visual, providing mechanisms for learning that are not available in most face-to-face classroom...
environments (Bransford, Brown, & Cocking, 2000; Christensen, Horn, & Johnson, 2008).

Yet, while online instruction does clearly offer a wide range of features not readily accessible in the physical classroom, challenges often arise in enabling participants to actually demonstrate what they know. Instead, online instruction focusing on acquisition of a particular skill is usually “slide based,” with learners progressing from one concept to the next in a fairly linear manner. What is often lacking from this process is the sense that the participant is experiencing a complex life-like scenario (Hron & Friedrich, 2003). As noted by Bonk and Graham (2005), the absence of meaningful face-to-face social interaction may even impede the entire online learning process.

Consequently, due to the challenges of mimicking what may actually occur in the physical world, it is thus necessary to develop ways in which a richer level of understanding can be fostered online. Although one option is to develop high-end software simulations, a more realistic and cost-effective solution is to provide users with downloadable competency-based documents that can be printed out and incorporated into face-to-face training sessions, in conjunction with other online activities. An essential element of this process is the facilitation of instructive and formative assessment of hands-on tasks, along with ways in which new understandings can be re-enforced through online mechanisms (Johnson & Johnson, 2004). In short, a blended approach is often a necessity.

To examine the distinctions between online and hands-on learning, this study reports on the findings from a course that incorporated both virtual and face-to-face elements. The research question upon which this study was based is as follows:

- Did online learners with greater improvement on their pre- and posttest scores exhibit significantly greater likelihood in demonstrating competency during the hands-on portion of the course?

**Theoretical framework**

The justification for the incorporation of hands-on activities within an online course exists in educational theory. The most common pedagogical approach within online education has traditionally been objectivism. With an objectivist instructional approach, the goal of learning is to gain the knowledge that is transmitted. For example, learners are often expected to read a series of slides and then complete an online multiple-choice examination. Yet, this means of conveying knowledge is not likely to be effective when focusing on complex problem-solving tasks involving the actual demonstration of what people know (Gagné, Briggs, & Wager, 1992).

Constructivism is an alternative educational paradigm, holding that knowledge is not conveyed directly from one learner to another, but is “constructed” by individuals. Within this epistemology, learning is considered to be an active process in which meaning comes from experience. In this type of classroom environment, students learn from sharing perspectives with others, often in social contexts, and adjust their previously held notions accordingly in order to respond to new perspectives (Duffy & Jonassen, 1992). Therefore, following constructivist reasoning, learning should take place in authentic, hands-on manner in which students have
many opportunities to build their understanding and to be able to practice transferring their knowledge and skills to new situations (Cho & Schunn, 2003).

More specifically, Lave and Wenger (1991) argued that learning should be considered as a situational activity that has at its foundation a process referred to as “legitimate peripheral participation.” In this regard, novices have the opportunity to learn how to respond to a given situation based on watching and learning with an expert who has a high level of knowledge and skill, as specified by the given situation. They asserted that learning could then become more social and interactive, with challenging tasks that can be best accomplished through guided instruction. Likewise, Lave and Wenger’s (1991) primary unit of analysis was not the individual as learner, or the institutions in which learners interacted, but the “communities of practice” which people formed as they pursued shared enterprises. Taking each of the defining characteristics of this theory into consideration, Wenger (1998) then defined the notion of a community of practice as being characterized by coherence through mutual engagement in a meaningful joint enterprise, thereby producing interdependent relationships sustained by mutual accountability. Within the community, social practices were said to emerge as resources for negotiating meaning. Practices included routines, tools, ways of doing things, shared stories, and gestures.

Although communities of practice can exist online, such as within discussion boards and newsgroups, several researchers have indicated that entirely online learning environments generally fail to provide the communication mechanisms that learners often need in order to advance (Bonk & Graham, 2005). Rather, what is called for is the inclusion of blended approaches, which have elements of authentic participation in online environments. But how can this be achieved?

As noted by Garrison and Kanuka (2004), this fusion of hands-on and online learning can result in an enhanced learning experience, primarily because course participants are able to better develop critical thinking skills while also collaborating with peers in a manner that is difficult, if not impossible, to foster with just one learning modality. Examples of this blended approach’s success in the literature are predominantly found in undergraduate level degree programs. For instance, at the University of Central Florida, Dziuban, Hartman, Juge, Moskal, and Sorg (2006) asserted that students participating in more than 100 blended courses performed at a higher level, while also indicating a more significant degree of satisfaction than learners in solely face-to-face courses and fully online courses. Further, faculty teaching the blended courses also noted these performance and attitudinal differences. Dirkx and Smith (2004) also found that learners in solely online courses are often reluctant, frustrated, and dissatisfied with virtual collaborative learning methods, especially when working within small online groups, because they “struggle with the development of a sense of interdependence and intersubjectivity within their online groups, but end up holding fast to subjective, individualistic conceptions of learning” (p. 134). The authors additionally suggested that these aspects can be exacerbated in entirely online environments, due to the difficulty in providing the emotional dynamics, which are often cited as being a critical element of the collaborative learning process. Likewise, Kirkley and Kirkley (2005) argued that difficulties might be more likely to occur when online learners try to reach a consensus in online group work, since there are no verbal or facial cues to help resolve possible conflicts. An adequate solution is, thus, to enhance online modalities, when possible, with traditional elements of the face-to-face instruction.
Although less pronounced at the K-12 level as a curriculum trend, blended learning has still been gaining a foothold in US schools. In recent years, an emphasis on Web 2.0 technologies combined with more technologically oriented preservice education programs has resulted in new instructional modalities. Many educators and administrators have thus looked to blended learning more so than in the past. For instance, in *Disrupting Class*, Christensen et al. (2008) note that by 2019, 50% of all high-school courses in the United States are likely to be delivered online, with blended learning being a key component. The implications of this trend are promising, given that the technologies available for the incorporation of face-to-face curricula in online courses continue to improve, with more educators becoming aware of how to combine both modalities and leverage the benefits.

In addition to new realizations within the literature on the need for blended learning, there have also been efforts in evaluating the effectiveness of such endeavors.

To assess effectiveness, a regression-based model can be applied to evaluate the association between students’ scores in a test instrument, in order to predict their subsequent performance (Allen & Yen, 2001; Crocker & Algina, 2006). Regression-based approaches examine the association between two measures where, for example, a student’s test score is assumed to predict an outcome (i.e. subsequent performance); that is, the variability in the outcome measure is explained using the test score. This means that if there is greater proportion of variance accounted for by the test score, then the regression-based model implies that the test achieved a level of predictive validity. In fact, many large-scale assessments use this method to strengthen the predictive validity of their tests. For example, the Scholastic Aptitude Test (College Board, 2008) treats their assessment as a measurement of students’ high-school scholastic ability and uses students’ first-year college grade point average as the outcome variable to measure their performance in the future. From a blended-learning environment, Lynch and Dembo (2004) conducted a study that examined the predictive effect of self-regulation on the final grades of students. Using correlations and regression-based analyses, they examined whether self-regulatory attributes were predictive of distance learner success. They concluded that inferences based on strong associations between the two were implications of predictive validation for the effectiveness of the assessment.

The implications of this model for the evaluation of blended learning environments are noteworthy. Although traditional online evaluation procedures are designed to rank students by their overall performance, it is also necessary in blended environments to implement further evaluation components that can link pre- and postassessments and course knowledge to fine-grained hands-on tasks that are additionally measured in the face-to-face environment. As such, this extends beyond broad domain-based scores that have been found to be difficult to interpret in conjunction with demonstrated performance. In other words, based on test and hands-on performance, learner’s profiles (i.e. a list of competencies that a specific participant has demonstrated to perform well) can be created to provide diagnostic feedback for further instruction and training purposes. It is from this dual-assessment component of the online and face-to-face sections that adds to the effectiveness of the blended environment.

Recently, studies have also evaluated the blended course to establish both validity and reliability for online learning environments. In Barnard, Lan, To, Paton, and Lai’s (2009) recent study, a confirmatory factor analysis was used to separately
test the validity and the reliability of online learners and blended learners on their measurement of self-regulation. Confirmatory factor analysis allows a reliable measure of a directly unobserved construct (e.g. students’ performance, ability, or psychological perception) using several observable measures. This approach has been used for assessing psychological measures due to its capability of addressing both reliability and validity issues (see Bollen, 1989). They found that their approach supported validity for a higher-order factor that was measured in their study. They noted that further validation utilizing information from both online and blended learning environments will be in need as the demand for courses that deviate from traditional face-to-face environments increases.

The aforementioned evaluation approaches provide the analytical framework for this study. The online portion of the course can be thought of as the assessment, which measures the effectiveness of the course, whereas the face-to-face component of the course can be considered as a measurement of future performance. The treatment of the online course and the hands-on section to follow the framework of validity studies is unique to this study and is discussed further in the “results” section.

**Blended course design**

The blended course examined for this study was specifically designed for the public health workforce. It was freely available from March 2005 until March 2009 as a resource. This first portion was intended to be an online training program to provide the knowledge required to prepare learners for how to respond to natural and human-made disasters. It included a pretest, interactive slides, and then a posttest. The second phase involved the incorporation of hands-on face-to-face activities, such as the inclusion of a downloadable follow-up evaluation. Figure 1 illustrates the curricular flow of the online course.

The printed follow-up evaluation portion of the training needed to be completed at the participant’s workplace and was entirely hands-on. Participants were asked to work with colleagues to determine how they would solve the problem during an emergency, what their new functional role might be, what type of equipment they would need to use, and who they should contact for back-up support. As a means of verification, the learner’s supervisor then took on the responsibility of approving the completed electronic form and verifying in the online learning management system that the participant’s performance was satisfactory. The supervisor’s approval was key to the reliability of the follow-up evaluation. It not only provided face-to-face validity of the employee’s response but also functioned as a source of information to

![Figure 1. Curricular flow of the online course.](image-url)
confirm the curricular value of the online course. At this point, the learner could also receive an online certificate of completion.

Methods

Results from the follow-up evaluation were used to assess the effectiveness of the blended course. In other words, it served as validation of the course’s impact. Current studies on the effectiveness of online courses rely on the pre- and posttest scores of participants. The method of analysis conducted was a combination of linear and logistic regressions (Agresti, 2002).

To account for pretest and posttest changes as predictors for participants’ response in the follow-up evaluation, a difference score between the pre- and the posttest scores was first calculated. Here, the difference scores were assumed to be the educational change resulting from the course. Using the difference score as a predictor, a logistic regression was fit for items that had dichotomous responses (items 3 and 4 from the follow-up evaluation), and a linear regression was fit for items with continuous outcomes (item 5 from the follow-up evaluation). Figure 2 shows the selected items from the follow-up survey used for this analysis. Three items from the follow-up survey were selected as outcome variables for the analysis; these items represented quantifiable variables, whereas the remaining items were qualitative. Item 3 asked respondents whether they understood their division’s role, and item 4 asked whether they had practiced their functional roles. The logistic regressions modeled the likelihood in which the respondents answered “yes” given their difference score. Item 5 asked respondents to check a list of eight communication equipment items that they were supposed to know how to use. This was converted to a score out of 8; the difference score was regressed on this score to predict the number of communication equipment items.

The regression models attempted to predict the likelihood that the respondent had a greater role in understanding his or her job after completing the course. Figure 3 shows a path diagram that illustrates the analytical framework discussed. The primary assumption in this analysis was that the greater the difference score, the greater the likelihood of a participant say “yes” and subsequently indicate knowing more.

Data sources

This online course was developed and funded through a partnership between the Centers for Disease Control (CDC) and a large university in the northeastern United States, with all of the data being downloaded from a secure MySQL database. Based on over 6000 participants who completed the online course, 1676 respondents, representing 719 unique workplaces from over 12 countries and 42 states within the United States, completed the follow-up evaluation to be used for this study.

Results

Based on results from the follow-up evaluation, this study provides an analysis of participants’ performance on their pretest (\(M = 74.85, SD = 18.70\)) and posttest (\(M = 91.62, SD = 10.41\)) scores, with posttest scores showing a significant improvement from the pretest scores, \(t(1676) = 41.53, p < 0.001\).
Figure 4 shows a scatter plot and the best linear fit of the pretest and the posttest scores. The estimated slope, which indicates the incremental change between the pretest and posttest scores, was 1.17 points, \( p < 0.001 \), showing a significant change in the online students’ scores.
The reliability of the pre- and the posttest items was 0.73 using Cronbach’s alpha coefficient, showing that the test was a reliable measurement of the participants’ ability using the reliability threshold set by Nunnally (1978). The pretest and posttest
data show that on average, as the participants’ pretest scores increased, their posttest scores increased by 0.265 points ($p < 0.001$). However, to use the printed “hands-on” follow-up evaluation as a validation tool, we used the participant responses as the outcome variable and the difference scores as the predictor, to test whether the entire blended online/face-to-face course was effective. Consequently, as the difference score between the pre- and the posttest increased, we sought to determine if there was a greater likelihood that the participant actually demonstrated his or her knowledge while participating in the hands-on portion of the course.

Results showed that the blended course was significantly effective when assessing the respondents’ application of skills. The likelihood that a participant understood his or her division’s role was 1.01 times greater ($p < 0.025$) than a participant who did not understand his or her role for every increase in the difference score, controlling for the effect that the participant reviewed the content of the course. When controlling for the difference score, the likelihood that a worker who reviewed the course contents actually understood his or her division’s role was 13.80 times greater than someone who did not review its contents. Further, when shown their functional roles, the likelihood that participants had practiced these roles was again 1.01 times greater ($p < 0.022$) as their difference score increased (see Table 1).

Item 5 inquired about the participant’s knowledge of using communication equipment. Among eight possible types of equipment listed, as the difference score increased, the results indicated that the participant gained competency in using 0.016 more types of equipment ($p < 0.001$) (see Table 2).

### Discussion

Findings from this study indicate that the incorporation of face-to-face tasks in an online course adds considerable value, through improved learning outcomes and knowledge gained. The results from this analysis showed not only the effectiveness of the blended design but also the predictive validity of the online course through the follow-up hands-on assessment. In particular, the item analysis of the proportion of correctly answered test questions illustrates that item 2, pertaining to the learners’ understanding of the incident command system (ICS) – an organizational structure

<table>
<thead>
<tr>
<th>Predictor</th>
<th>$B$</th>
<th>$SE$</th>
<th>$B$</th>
<th>$e^B$</th>
<th>Predictor</th>
<th>$B$</th>
<th>$SE$</th>
<th>$B$</th>
<th>$e^B$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Difference score</td>
<td>0.009</td>
<td>0.004</td>
<td>1.009</td>
<td></td>
<td>Difference score</td>
<td>0.007*</td>
<td>0.003</td>
<td>1.007</td>
<td></td>
</tr>
<tr>
<td>I have reviewed its contents</td>
<td>2.624</td>
<td>0.138</td>
<td>13.797</td>
<td></td>
<td>Constant</td>
<td>0.971***</td>
<td>0.077</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>-0.078</td>
<td>0.113</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: $e^B = \text{exponentiated } B$. Items coded as 1 for yes and 0 for no. 
* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.  

Table 1. Summary of logistic regression for selected items in the follow-up evaluation.
used in the public health field to improve emergency response operations (Gebbie, Valas, Merrill, & Morse, 2006) – exhibited the greatest point difference in improvement. The ICS portion of this course was intended to provide learners with an enhanced understanding of their functional roles during an emergency situation. Since these functional roles were often different than what learners might do during day-to-day activities, a proper understanding of the new tasks involved was a fundamental aim of the course.

Further, when controlling for the difference score, the likelihood that a participant who reviewed the course contents actually understood his or her division’s ICS role for the hands-on portion of the course was 13.80 times greater than someone who did not review its contents. This latter finding suggests that learners were able to transfer and synthesize the knowledge gained from the online, didactic portion of the course (consisting of the pre- and posttests) to the hands-on, face-to-face activity. This was evident for all of the job roles, ranging from clinicians to those in information technology. More specifically, when considering that the primary aim of this blended course was to enable participants to gain a stronger familiarity with their potential functional roles during an emergency response, it is clear that this objective was achieved.

Additionally, when examining these findings in relation to the participants’ job roles, the implications are also illuminating. For instance, while participants working in the information systems field exhibited the highest mean difference score (21.49) on the pre- and the posttests, those working in the laboratory had the lowest (12.17). Likewise, the likelihood that participants who reviewed the course content sought to further understand their job roles was 58.2 times greater for those in information systems, while it was only 19.0 times greater for laboratory staff, than those who did not review their job roles. These findings suggest that the participants’ job role was a key indicator of performance on the hands-on portion of the course. More specifically, the blended learning modality seems to have benefited those working at computer work stations more so than those performing various procedures in a laboratory setting. These distinctions need to be analyzed more closely and will be the subject of future research. It is certainly possible that the information systems staff may have been more adept at completing and submitting the online form, and receiving subsequent follow-up information electronically from their supervisors. In other words, the information systems staff were most likely working in an environment that was more conducive to distance learning, while also possessing the self-regulatory attributes that are often predictive of distance learner success.

Table 2. Summary of regression analysis for variables predicting the number of communication equipment items in the follow-up evaluation.

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>SE B</th>
<th>β</th>
</tr>
</thead>
<tbody>
<tr>
<td>Difference score</td>
<td>0.016</td>
<td>0.004</td>
<td>0.102***</td>
</tr>
<tr>
<td>Constant</td>
<td>5.855</td>
<td>0.088</td>
<td></td>
</tr>
<tr>
<td>R²</td>
<td></td>
<td>0.011</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td></td>
<td>17.750</td>
<td></td>
</tr>
</tbody>
</table>

Note: *p < 0.05; **p < 0.01; ***p < 0.001.
The example presented using strata comparison by position shows another advantage to the blended course design. Repeated measures in the effectiveness of the course content using both online and hands-on features added to the implication of differences that may not have been intuitive when only the online portion of the course was evaluated. Further, as indicated in our review of the literature, the intent to evaluate both online and hands-on mediums in a single course is not very common. Although a confirmatory factor analysis model is often applied in studies of validity to evaluate the association between students’ scores in printed test instruments to predict learners’ subsequent performance, this approach is rarely integrated into evaluations of blended courses.

Conclusion
When online courses include hands-on, face-to-face tasks in which students need to transfer their knowledge and skills to new situations (Cho & Schunn, 2003), the evaluation of the entire learning process is critical. In short, how can we ensure that knowledge transfer from one modality to another is actually taking place? This study evaluated this process from the virtual to the hands-on, by first considering the effectiveness of overall blended course design, and then the predictive validity of the online course through the follow-up hands-on assessment.

Within the larger realm of pedagogical theory, this form of analysis can help answer the perennial question: How do people learn best in blended online/face-to-face environments? Although this study only examined the probability in which an online learner might demonstrate an enhanced understanding of a hands-on skill, the findings nonetheless provide a window into the knowledge transfer process from objectivist to hands-on-based tasks.

The evaluation approach outlined in the proceeding paragraphs is also particularly important, since most learning situations are inherently social activities (Lave & Wenger, 1991), with actual participation as a primary component. In this regard, the hands-on component of this online course was an essential mechanism for bringing the online learners closer to new realizations about their functional roles during emergency response. Although these same realizations could have occurred in an entirely online course, the learners’ ability to practice in their own “face-to-face” work environment clearly added value. Thus, by analyzing the effectiveness of the online and face-to-face elements in a single course, this study has the potential to help other educators to better design and facilitate other instructional modalities. Blended learning is an emerging area of research, and one in which new evaluation approaches are sorely needed.

In the future, the authors intend to conduct further analysis of the hands-on elements of this learning environment, in order to assess the ways in which specific competencies were understood by different groups of learners. For instance, since participants in some job roles exhibited much less likelihood than others to engage in the hands-on tasks, more attention needs to be paid to the reasons why this has occurred. The continued usage of a regression-based evaluation model to predict subsequent performance on the hands-on assessment will make this possible.

Notes on contributors
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