Does Interactivity Matter for Females to Learn Computer Skills On-line

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Abstract: - The purpose of this study was to investigate the effect of level-of-interactivity of e-learning courseware on e-learners’ achievement while learning computer graphics skills on-line. One hundred and twenty one e-learners participated in this study. The effects of interactivity and gender on e-learners’ performance were examined. A significant interactivity-gender interaction was found on participants’ e-learning performance. The results indicated that (a) under the high-interactivity mode, male and female learners performed equally, but while under the low-interactivity mode, male outperformed female learners; (b) male learners performed equally under the high-interactivity mode and the low-interactivity mode, female learners, however, performed better while under the high-interactivity mode. It was concluded that e-learning courseware with high of interactivity will compensate for female learners’ gender differences and best fit their learning needs.

Key-Words: - E-learning, Interactivity, Instructional design, Gender difference

1 Introduction
In recent years, the rapid growth of Internet technology has changed the nature of interaction especially for online learning environments. As a result, there are increasing concerns towards interaction issues of e-learning. Accordingly, the use of interactivity as a variable in empirical studies has dramatically increased with the emergence of new communication technologies such as the Internet. Nowadays, interactivity has become a synonym of quality learning. Engaging learners in the learning process is the pre-requisite for effective e-learning. However, making learning more engaging relies on considerate design of learning activities that allow learners to participate and involved in the learning process. In other words, the design of learning activities must be able to incorporate interactivity into learning process to make learning become engaging and effective. Therefore, interactivity is not just necessary and fundamental in the knowledge acquisition process but also an intrinsic factor for successful and effective online learning [1], [2], [3], [4], [5], [6].

2 Interactivity for on-line learning
Interaction is a two-way communication process. Norman suggested that the interactive process is a repeated looping of decision sequence of a learner’s action and the environment’s reaction [7]. Kiousis asserted that interactivity is the degree to which a communication technology can create a mediated environment in which participants can participate in reciprocal message exchanges in the forms of one-to-one, one-to-many, and many-to-many communication and both synchronously and asynchronously [8]. Therefore, interactivity consists of three factors, including the technological structure of the media employed, the characteristics of communication settings, and individuals’ perceptions [9]. Furthermore, based on the instructional quality of the interaction, Schwier and Misanchuk identified three levels of interaction, including reactive, proactive, and mutual interactions [10]. A reactive interaction is a response to a given question. Proactive interaction involves learner construction and generation activities during the learning process. And in a mutual interactive environment, the learner and system are mutually adaptive in reactions with each other. The relationships among the three levels of interaction are hierarchical in terms of quality of interaction. The quality of a mutual-level interaction is higher than that of a proactive-level interaction, and the quality of a proactive-level interaction is higher than that of a reactive-level interaction. In other words, higher levels of interaction provide greater opportunity for mental engagement and learner involvement than the lower ones in the learning process [10].

The quality of interaction is a function of the learner’s response and the computer’s feedback [11].
If the response matches the learner’s needs, then it is meaningful to the learner. Therefore, interactive learning has to be more than just clicking on and bringing up pop-up menus. Instead, it has to mean more than pointing and clicking and being involving and personal to the learner. However, whether a specific implemented strategy can enhance the interactivity of on-line learning needs to be further examined. Therefore, it is necessary to explore more strategies and examine the effects in increasing the level of interaction of web-based learning in order to attract and engage learners more actively.

3 Individual differences

The individual predispositions somehow condition learners’ readiness to benefit from the provided instructional environment. Learners had to fit the instructional environment as given; some benefited more, some less and some not at all. In the field of computer skills learning, prior knowledge has been suggested to dominate learners’ performance. Individual differences in background and prior experience have been found to affect the performance and attitude of users of computers [12], [13]. Prior knowledge is either a necessary or at least a facilitating factor in the acquisition of new knowledge in the same content domain. Individuals who have greater knowledge will learn more quickly and more effectively. The domain-specific expertise has been found to be the most important difference between novices and experts in various knowledge domains, such as physics [14], algebra [15], geometry [16], and computers [17]. Previous studies have shown that the most reliable predictions of computing attitude and achievement are based on the amount of prior computing knowledge [18], [19]. Therefore, it is important to examine learners’ prior knowledge along with learners’ performance in learning computer skills.

Previous computer science education studies have indicated a disproportionate low number of females in the computer science domain [20], [21]. The U.S. Department of Education also found that there was no difference for male and female high school students in the enrolment of computer-related courses, but their preferences in types of courses showed significant different between groups [22]. Singh, Darlington, and Allen also indicated that women’s numbers in computer related majors have continued to decline in recent years [23]. The phenomenon of gender differences and similarities has implications for education. Therefore, it is worthy to examine how girls and boys benefit from a specific type of computer-based learning activity, so that educators can deliver instruction and deploy instructional resources adapting to learners’ needs.

4 Methods

4.1 Research design

A quasi-experimental design was employed to examine the effect of level-of-interactivity of e-learning courseware on e-learners’ achievement in a 3-hour computer graphics e-learning course. Two versions of e-learning courseware were employed to provide e-learners with different levels of interactivity, the high-interactivity courseware and the low-interactivity courseware. The levels of interactivity were distinguished by the instructional strategies implemented in the content presentation, prior-knowledge connection, and practice sessions of the e-learning courseware. Learners are allowed to finish the on-line course in a 2-week period based on personal needs and time available. Due to the pervasive noticed gender differences in the field of computer education, female learners’ performance and attitudes were also examined with contrast to the males in the present study. For eliminating the dominant effect of prior-knowledge, Analysis of Covariance (ANCOVA) was conducted on learners’ performance with learners’ self-reported level of computer skills as a covariate. The significance level was .05 for the present study.

4.2 Participants

There were one hundred and twenty one e-learners who are taking the computer graphics e-learning course participated in this study. Participants were randomly assigned to either the high-interactivity group or the low-interactivity group. For considering the fidelity of learners’ involvement in the e-learning course, only those who had participated in the learning activities for more than 90 minutes were identified as the effective sample for the analysis. The numbers of participants for each group are shown in Table 1.

<table>
<thead>
<tr>
<th></th>
<th>High-Interactivity</th>
<th>Low-Interactivity</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>27</td>
<td>24</td>
<td>51</td>
</tr>
<tr>
<td>Female</td>
<td>20</td>
<td>21</td>
<td>41</td>
</tr>
<tr>
<td>Total</td>
<td>47</td>
<td>45</td>
<td>92</td>
</tr>
</tbody>
</table>

4.3 The interactive learning materials

An e-learning courseware was employed to provide a 3-hour tutorial with practice sessions on the computer...
graphics concepts and hands-on practice of measuring geometric shapes to the learners. The common format of the employed e-learning courseware was designed using Flash multimedia and followed the principle of nine instructional events and provided learners with learning events of (1) gaining attention, (2) informing the learner of the objective, (3) stimulating recall of prerequisite learning, (4) presenting stimulus materials, (5) providing learning guidance, (6) eliciting performance, (7) providing feedback, (8) assessing performance, and (9) enhancing retention and transfer [24]. Therefore, the pre-set learning goals can be achieved successfully by the learners.

Two versions of the e-learning courseware were developed based on the common format of the tutorial courseware with different levels of interactivity implemented in the content presentation, prior-knowledge connection, and practice sessions. As shown in Table 2, the low-interactivity version employed interactive navigational functions with page-browsing content presentation, keyword-highlight prior-knowledge connection, and fill-the-blank practice. In contrast, the high-interactivity version employed higher levels of interactivity design such as learner-control-browsing for content presentation, keyword-hyperlink for prior-knowledge connection, and interactive practice, but equipped with the same interactive navigational functions as the low-interactivity version did. Therefore, the research can infer learners’ difference in performance and attitudes back to the level-of-interactivity reasonably. The design of levels of interactivity of the e-learning courseware is shown in Figure 1, Figure 2, and Figure 3.

Table 2 The design of levels of interactivity of the e-learning courseware

<table>
<thead>
<tr>
<th>Content presentation</th>
<th>Low-interactivity</th>
<th>High-interactivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Page-browsing</td>
<td>Learner-control browsing</td>
<td></td>
</tr>
<tr>
<td>Keyword-highlight</td>
<td>Keyword-hyperlink</td>
<td></td>
</tr>
<tr>
<td>Fill-the-blank practice</td>
<td>Interactive practice</td>
<td></td>
</tr>
</tbody>
</table>

4.3 Instruments

An achievement test was developed and conducted to collect participants’ performance in the computer graphics e-learning course. The achievement test was developed by the domain expert and revised by the researcher. The achievement test consisted of 20 fill-the-blank items and was conducted in the form of paper/pencil test immediately after the given 2-week learning period in the learner center where e-learners come to a monthly face-to-face course session. The internal consistent reliability was .71 as measured by Cronbach’s α.

Fig 1. The high-interactivity version employed learner-control-browsing for content presentation

Fig 2. The high-interactivity version employed keyword-hyperlink for prior-knowledge connection support

Fig 3. The high-interactivity version employed interactive practice
5 Findings
The group means of participants’ e-learning performance are shown in Table 3. The overall mean score for all participants was 14.58. The mean score of males was 15.10 and was slightly higher than the mean score of females (mean=13.96). For the level-of-interactivity groups, the mean score of the high-interactivity group was 15.36 and was higher than the mean score of the low-interactivity group (mean=13.78). As for the interactivity-gender groups, the low-interactivity female group scored the lowest among four groups.

Table 3 Summary of group means of e-learning performance

<table>
<thead>
<tr>
<th>Gender</th>
<th>Interactivity</th>
<th>Mean</th>
<th>SD</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>Hi-interactivity</td>
<td>15.18</td>
<td>3.00</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>Low-interactivity</td>
<td>15.00</td>
<td>4.42</td>
<td>24</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>15.10</td>
<td>3.70</td>
<td>51</td>
</tr>
<tr>
<td>Female</td>
<td>Hi-interactivity</td>
<td>15.60</td>
<td>3.04</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Low-interactivity</td>
<td>12.38</td>
<td>4.22</td>
<td>21</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>13.96</td>
<td>3.64</td>
<td>41</td>
</tr>
<tr>
<td></td>
<td>Hi-interactivity</td>
<td>15.36</td>
<td>3.04</td>
<td>47</td>
</tr>
<tr>
<td></td>
<td>Low-interactivity</td>
<td>13.78</td>
<td>4.48</td>
<td>45</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>14.88</td>
<td>3.76</td>
<td>92</td>
</tr>
</tbody>
</table>

5.1 The simple main effect analysis on interactivity
One-way ANCOVA analyses were conducted to examine the simple main effect of gender and level-of-interactivity on participants’ e-learning performance, respectively, with prior-knowledge as a covariate. First, the ANCOVA summary for the high-interactivity group is shown in Table 5. For the high-interactivity group, the simple main effect of gender on e-learning performance was not significant \((F_{(1,44)=3.425, p=.071})\). The result indicated that males (mean=15.18) and females (mean=15.60) performed equally while learning from the high-interactivity e-learning courseware. That is to say, female learners performed as well as males when learning from a highly interactive courseware.

Likewise, the ANCOVA summary for the low-interactivity group is shown in Table 6. For the low-interactivity group, the simple main effect of gender on e-learning performance was not significant The simple main effect of gender on e-learning performance was significant \((F_{(1,42)=4.674, p=.036})\). The result indicated that males (mean=15.00) outperformed females (mean=12.38) while learning from the low-interactivity courseware. In other words, females performed poorly when learning from a low-interactivity courseware, but male learners performed equally no matter the levels of interactivity.

5.2 The simple main effect analysis on gender
Similarly, one-way ANCOVA was conducted to examine the simple main effect of level-of-interactivity on participants’ e-learning performance with prior-knowledge as a covariate. As shown in Table 7, the ANCOVA summary for the male group revealed that the simple main effect of level-of-interactivity was not significant \((F_{(1, 48)=3.19, p=.575})\). The result indicated that the level-of-interactivity did not affect male learners’ e-learning performance. They performed equally no matter the levels of interactivity of e-learning courseware.

In contrast, as shown in Table 8, the ANCOVA summary for the female group indicated that the simple main effect of level-of-interactivity was
significant \( (F_{(1, 38)}=11.576, p=.002) \). In other words, that female learners performed better in the high-interactivity e-learning \( (\text{mean}=15.60) \) than in the low-interactivity e-learning \( (\text{mean}=12.38) \).

### Table 7 Summary of simple main effect analysis for the male group

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prior-knowledge</td>
<td>2.610</td>
<td>1</td>
<td>2.610</td>
<td>1.081</td>
<td>304</td>
</tr>
<tr>
<td>Interactivity</td>
<td>773</td>
<td>1</td>
<td>773</td>
<td>319</td>
<td>575</td>
</tr>
<tr>
<td>Error</td>
<td>115.908</td>
<td>.48</td>
<td>2.415</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table 8 Summary of simple main effect analysis for the female group

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prior-knowledge</td>
<td>2.212</td>
<td>1</td>
<td>2.212</td>
<td>.911</td>
<td>346</td>
</tr>
<tr>
<td>Interactivity</td>
<td>28.096</td>
<td>1</td>
<td>28.096</td>
<td>11.576</td>
<td>.002</td>
</tr>
<tr>
<td>Error</td>
<td>92.227</td>
<td>.38</td>
<td>2.427</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

6 Conclusion

Interactivity is the key to successful on-line learning for learners. Through high level of interaction, learners will be able to acquire the learning content based on individual needs, correct misconceptions, and develop into independent learners more efficiently. In the present study, levels of interactivity were implemented in e-learning courseware to provide levels of learner-content interaction for the learners to learn computer skills on-line. In other words, the scope of interactivity examined in the study was only limited to the human-machine interaction, especially the cognitive interaction for learners to comprehend the learning content.

In the present study the male learners performed equally in the high-interactive courseware and the low-interactive courseware. In other words, lower interactivity of the courseware did not affect male learners’ performance. This may imply that male learners possessed certain characteristics to compensate for the lower interactivity of the courseware, or the instructional design of the low-interactivity version courseware was sufficient in supporting those learners to achieve the learning goals. In contrast, for the female learners, probably due to female learners’ gender characteristics, the low-interactivity version courseware was insufficient in supporting success in the e-learning with comparison to the high-interactivity version. Therefore, it can be reasonably inferred that the high-interactivity of e-learning courseware could compensate for female learners’ gender characteristics and bring about better performance.

To sum up, the results of the simple main effect analyses for the significant interactivity-gender interaction on participants’ e-learning performance is shown in Figure 4 and indicated that (a) under the high-interactivity mode, male and female learners performed equally, but while under the low-interactivity mode, males outperformed female learners; (b) male learners performed equally no matter the levels of interactivity of e-learning courseware, female learners, however, performed better while under the high-interactivity mode. As shown in Figure 4, it can be inferred that the high-interactivity of e-learning courseware will compensate for female learners’ individual difference and help them achieve better performance. Therefore, the implication is that the development of courseware for female learners to learning computers kills on-line should employed higher level of interactivity in the design in order to enhance female learners’ performance.

### Fig 4. The interactivity-gender interaction on e-learning performance

Although, interactivity brings forth higher learning quality for the learners, Reichert and Hartmann indicated that only few computer based learning environments satisfy the demand for a high degree of interactivity [25]. Educational software needs to correspond to the modern multimedia technologies to attract and motivate the learners. Most of the time, the employed leading technologies dramatically increase the cost of the development. How to design e-learning courseware to focus on fundamental concepts and skills of a domain and address various cognitive levels in order to possess long-lived value and, therefore, maintain the cost-effectiveness at a reasonable level has become a subsequent issue for on-line learning.
References:


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