Gender Differential Item Functioning (GDIF) Analysis for the Meaningful E-Learning Instrument

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Abstract: - E-Learning is an important concept and application for all life-long learners especially to college students and teachers. A learner’s level of meaningful e-learning can be measured using a valid and reliable measuring instrument. In Malaysia, there is a measuring instrument to measure meaningful e-learning for students in colleges and universities namely the Meaningful e-Training (MeT) instrument. This study aimed to determine whether there are differences in meaningful e-learning scores between male and female students in Malaysia. The study also aimed to find out if there is gender bias in the items of the meaningful e-learning instrument. This study used survey design. SPSS and WINSTEP software were used for data analysis to answer the research questions of the study. The findings shows that there is no significant differences between meaningful e-learning among male and female students ($M_{\text{male}} = 46.68$ dan $SD = 5.11$ : $M_{\text{female}} = 46.96$ dan $SD = 5.11$). The t-test analysis performed gave the result of Sig = 0.66. Review from the findings from gender item functioning or GDIF showed that there were only one item that still has GDIF and one item need attention which are b022 and b012. Thus, this instrument is fair to measure meaningful learning either for male of female students.

Key-Words: - GDIF, Meaningful Learning, E-Learning, Meaningful e-Training, Hybrid Learning

1 Introduction

Various attempts have been carried out to improve the quality of the Hybrid E-Training (HiT) instrument. Numerous analysis using a variety of techniques and methods based on either Classical Test Theory (CTT) or Item Response Theory (IRT) have been done. The fundamental difference of these two theories lies in the aspect of which is to be measured. IRT measurement does not focus only on the person but it also includes the item. These two theories are equally important in the measurement world because if we aim to come out with a highly reliable and valid instrument, we will have to start examining the items comprehensively from both angles. This study used two viewpoints to answer the research questions which are :

1) Does gender differences exists in the Hybrid e-Training instrument used in Malaysia? Classical Test Theory (CTT) approach in this study will attempt to answer the question of whether there is any significant difference in mean score between male and female in terms of meaningful learning.

2) Which items are still biased against male or female? Subsequently, using a similar approach to Item Response Theory (IRT) namely the Rasch Model, the researchers will attempt to answer the second question.

2 Problem Formulation

This study uses descriptive survey method. The population is composed of 295 students (77 males and 218 females) undergraduate third year between the ages of 21 to 25 years old randomly selected. Data was analyzed using SPSS version 11.5 and Winsteps 3.64.2. The MeT instrument was developed by a group of researchers led by Rosseni Din [1][2][3][4]. Meaningful e-learning in the instrument consisted of 22 items that test the five constructs, namely: cooperation (4 items), activity (5 items), authenticity (4 items), construction (3 items), and intentionality (6 items).

The data analysis techniques in this study will first observe the aspects of the mean and standard deviation. Further analysis techniques using Rasch Model was subsequently performed to identify the gender differential item functioning (GDIF) in the instrument. This step is important to improve the quality of the items in the next version.
of the instrument so that it will be able to avoid gender biasness.

3 Problem Solution and Discussion
This study aim to identify whether there are significant differences in mean scores between male and female. In addition, this study also aim to identify whether there is gender bias (GDIF) in the MeT instrument. Fig. 1(i)-1(vi) shows the demographic profile of respondents who answered the MeT test.
Table 1 and 2 shows the group statistics to answer the research question of whether or not there are differences in mean between the male and female group in answering the five constructs using the MeT survey instrument. Based on both tables it can be concluded that in general there is no significant differences between meaningful learning of male and female students.

Table 1: Group Statistics

<table>
<thead>
<tr>
<th>Gender</th>
<th>N</th>
<th>Mean</th>
<th>Std. Dev</th>
<th>Std. Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>77</td>
<td>46.68</td>
<td>5.11</td>
<td>.58</td>
</tr>
<tr>
<td>Female</td>
<td>218</td>
<td>46.96</td>
<td>4.82</td>
<td>.33</td>
</tr>
<tr>
<td>Total</td>
<td>295</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Independent Samples Test

<table>
<thead>
<tr>
<th>Levene's Test for Equality of Variances</th>
<th>t-test for Equality of Means</th>
</tr>
</thead>
<tbody>
<tr>
<td>F</td>
<td>Sig.</td>
</tr>
<tr>
<td>----</td>
<td>------</td>
</tr>
<tr>
<td>Equal variances assumed</td>
<td>.014</td>
</tr>
<tr>
<td>Equal variances not assumed</td>
<td>-.432</td>
</tr>
</tbody>
</table>

Subsequent gender analysis will be presented from the standpoint of the instrument to determine whether there is gender bias in the constructs used in the MeT instrument. A total of 295 respondent data were used to perform the GDIF analysis [7][8][9].

Item analysis to determine if gender bias exists in the MeT instrument was done using ver.3.64.2 Winstep software. To determine whether there is GDIF or not, three indicators were used [5], namely:

(i) t value of < -2.0 or > 2.0
(ii) DIF contrast value of < -0.5 or > 0.5
(iii) p (Probability) value < 0.05 atau > -0.05

The three indicators were examined accordingly. An item need to meet those three conditions to be considered bias and be drop from the instrument. However, if the item meets only one of the conditions, it should not be drop but instead it should be separated and fixed. Based on those characteristics, GDIF for the MeT constructs can be determined from Fig. 2-6.

Fig. 2 shows a good pattern both for male and female. There is not much gap or distance between both lines. The second item (B02) exhibit a little distance between the two lines suggesting the item is more difficult for females (Red line 2) and more convenient for male (Blue line 1). However, the visible distance is very close and not much difference can be measured thus it is save to conclude that no gender biasness exist in items for the first construct (Cooperation).

Fig. 2: GDIF for Cooperation Construct

Same as the first construct in Fig. 2, all five items in the second construct (Activity) as shown in Fig.3 does not show any sign of biasness where even the hardest item B06 seem to be easier for male students, but the values are not strong enough to make it a bias item. Therefore we would conclude that all five items are fair for both male and female students.

Fig. 3: GDIF for Activity Construct.

For the third construct Authenticity, when referred to Fig. 4, all items seems to have good values and fair for both male and female students. The t value of 1.94, if rounded
statistically will be 2.00. This value is the cut-off point for GDIF. DIF contrast value is above 0.5 which is 0.65. From the graph, the lines look far enough between male and female students. Going back to the item in question, it appears that item B012 is about recognizing problem. In this matters, females in general have been known to be able to identify problem easier than their male counterparts [6]. This does make sense because male tend to think in simpler terms and does not easily recognize small details or issues as a problem.

For the fourth construct **Constructivity**, all items measuring the construct have good values and fair for both male and female students. The construct try to gather information about how much struggle learners have to put up in order to become an expert and solve problems. Apparently there is also not much difference where male and female both have to struggle to solve problems particularly involving e-learning. This is not surprising as Malaysia have revealed herself as a developing country where male and female alike must struggle to obtain equal rights and opportunities to become experts in various fields.

For the last construct (**Intentionality**) as can be referred to in Fig. 5, item B22 meets all the 3 criteria to be given the verdict of gender bias. This item is easier for female as oppose to the male counterpart. These conclusion is drawn from the three evidences where first, the t value is 2.18 which is > 2.00. Secondly, the DIF contrast of 0.71 is way above 0.5. Lastly, it is evidence by the p value which is < 0.03. Thus this item is gender bias and should be drop from the instrument.

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There were several interesting issues in regards to the research findings. First, it was found that there was no significant difference found among males and females in terms of gaining meaningful learning when experiencing technology training. This shows that there is no difference in the ability of males and females to learn meaningfully using technology unlike what have been taken for granted by our society who believed that males expected to learn better about machines, tools and how things work. There is a clear pattern from this study that shows even though a female maybe in mathematics and scientific study program and never felt "at home" around machines and technology they are still capable of achieving meaningful learning when required to use technology in their learning experience.

Secondly, females were found to be able to identify problems easier than males. This may be so due to their awareness towards details when males usually takes things for granted. More often than not, males like to approach things in the simplest way possible which in turn may cause them to bypass some important details.
Both Malaysian males and females are resilient in struggling to be an expert in their field. This is a criteria needed for citizens in a developing country to move forward [10][11][12]. Another interesting phenomenon to be discuss is the biasness that exists in the item that ask about problems in relation to technology use to support critical and critical thinking. Surprisingly the item was easy for females to answer as compared to males which is contrary to what society beliefs and findings from previous studies[13][14][15]. Again, this is a welcoming phenomenon for a developing country such as Malaysia to move forward as a developed country.

4 Conclusion

Based on the findings of this study, it is save to conclude that MeT is a valid and reliable instrument since only one out of 22 items were found to be gender bias and another one only need to be improve in terms of sentence structure so that it could be more easily understood by the respondents. In short, a concluding table is presented in Table 3 summarizing the results of GDIF analysis done in this study.

Table 3: GDIF Summary

<table>
<thead>
<tr>
<th>Construct</th>
<th>Original Items</th>
<th>Item GDIF</th>
<th>Remaining Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooperation</td>
<td>b01, b02, b03, b04</td>
<td>0</td>
<td>'b01, b02, b03, b04</td>
</tr>
<tr>
<td>Activity</td>
<td>b05, b06, b07, b08, b09</td>
<td>0</td>
<td>b05, b06, b07, b08, b09</td>
</tr>
<tr>
<td>Authenticity</td>
<td>b10, b11, b12, b013</td>
<td>0</td>
<td>'b10, b11, b12, b013</td>
</tr>
<tr>
<td>Construction</td>
<td>'b14, b15, b16</td>
<td>0</td>
<td>'b14, b15, b16</td>
</tr>
<tr>
<td>Intentionality</td>
<td>b17, b18, b19, b20, b21, b22</td>
<td>1</td>
<td>'b17,b18, b19,b20, b21</td>
</tr>
</tbody>
</table>

| Total | 22 | 1 | 21 |

References:


