Scaffolding Intervention in Learning Statistics for Hospitality College Students: The Longitudinal Design

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ABSTRACT
The class quasi-experiment was conducted to determine whether using scaffolding teaching strategy enhanced student understanding of statistics concepts for students enrolled in an introductory course. In this two-year longitudinal study, students received scaffolding intervention in experimental group and traditional teaching method in control group. In particular, learning effectiveness difference was found in two groups. The pretest scores were found to do something with the improvement rate. Based on a theoretical framework of how students learn statistics, the preliminary results of this study indicated some evidence that these methods may improve student understanding of statistics concepts.

Keywords: Scaffolding, Statistics, Hospitality Education, Latent Growth Modelling

INTRODUCTION
Much attention has been focused on the ability of student employment and competency to meet with the relatively simple requirements of hospitality management. Some researchers found that hospitality students had done badly in mathematics, statistics and science and many students considered those courses which are irrelevant to the needs of hospitality industry (Robert, 1980). Statistics education historically has been regarded by many students as hard and unpleasant to learn and
can be viewed as a new and emerging discipline, when compared to the other area of study and inquiry. Many teachers or instructors also felt frustrated and unrewarded to teach. The research of statistics education even can seem to be an invisible, fragmented discipline.

The teaching and learning of statistics has impacted the curriculum in hospitality education. Many university students majoring in the hospitality management find the required statistics course to be blunt as well as difficult. Nevertheless, problem-solving is one of the extremely important competencies in the context of hospitality industry. Moore (1009) indicated, “Statistics has some claim to being a fundamental method of inquiry, a general way of thinking that is more important than any of the specific techniques that make up the discipline” (p.134).

Traditional teaching statistics resulted in students having low statistics knowledge, critical thinking and consequently transfer ability (Buuren, 2006). Usually, statistics has been regarded as a general course and separated the content from the content in terms of hospitality management. This study proposes a new module that removed this separation by using Scaffolding students to learn statistics. It describes the new module and compares the learning outcomes of students following the proposed Scaffolding intervention teaching with that of students following the traditional teaching. The purpose of the study was to investigate the statistics learning effectiveness by using Scaffolding teaching strategy which included motivating students’ logical reasoning ability, statistical thinking, and the attitudes toward statistical literacy during the required course-statistics for sophomore students in Taiwan. A quasi-experimental research design was used to investigate the changes in students’ statistics learning effectiveness. The research questions of this study were shown as the followings.

1) Are there differences of learning effectiveness between Scaffolding teaching and traditional teaching for Statistics courses in Hospitality Management department?

2) How will the differences of students’ through the statistical Scaffolding instruction?

THEORETICAL FRAMEWORK

Scaffolding had been found to play a key role in supporting students’ high-level
engagement by motivating creative and divergent thinking (Henningsen & Stein, 1997). Scaffolding has been defined as a process that enables students to carry out a task, solve problems or achieve a goal which would be beyond his/her unassisted efforts (Maccosker and Diezmann, 2009). It is a Vygotsky’s (1986) social development theory, which emphasizes on social interaction and the assistance provided to a learner in their zone of proximal development. Many researchers insisted Scaffolding can provide the opportunity for students to develop sense-making, independence, self-efficiency, efficacy and self-confidence whilst working mathematically. In addition, it occurs when students are assisted by others in constructing knowledge (Giraud, 1997; Lan, Hall and Lane, 2002; Williams, 2008). Most important, scaffolding supports students’ learning effectively from the students-centered rather than the teachers-centered through questioning or other approaches. It should be designed from the students’ ideas strategy because success is dependent on the adaptability to the student’s needs (Duffy and Cunningham, 1996, Williams, 2008).

METHODOLOGY
1. Design and Procedures

The Control and experimental Groups Design was used in the study showed as Figure 1. It included an experimental group and a comparison group. The experimental group contained 96 sophomores of hotel and restaurant management in vocational university. The control group contained 97 sophomores of same department and university except for different entrance time. The classes of this group were instructed with a traditional statistics teaching instruction, which involved regular calculation, remembering, and others. The students of this group didn’t have received any computer courses or simulation in the classes.

<table>
<thead>
<tr>
<th>Group</th>
<th>Pre-test</th>
<th>Treatment</th>
<th>Post-test 1</th>
<th>Treatment</th>
<th>Post-test 2</th>
<th>Treatment</th>
<th>Post-test 3</th>
<th>Treatment</th>
<th>Post-test 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>O₁</td>
<td></td>
<td>O₂</td>
<td></td>
<td>O₃</td>
<td></td>
<td>O₄</td>
<td></td>
<td>O₅</td>
</tr>
<tr>
<td>Experimental</td>
<td>O₆</td>
<td>X₁</td>
<td>O₇</td>
<td>X₂</td>
<td>O₈</td>
<td>X₃</td>
<td>O₉</td>
<td>X₄</td>
<td>O₁₀</td>
</tr>
</tbody>
</table>

Time

Figure 1. The Research Design
The experiment consisted between-subject design with two groups and four treatments (X₁, X₂, X₃, X₄). The between-subjects design ensured that the two groups are comparable with respect to their individual differences except the treatment. The two treatments varied the teaching strategies. Control group has been manipulated by traditional teaching method, and experimental group was using the Scaffolding teaching strategies. The basic design of the experiment to be conducted is as followings.

1. The entire sample of subjects was the sophomores of hotel and restaurant management who took the statistics courses. The subjects of control group were the students who took the statistics courses during the first year of this study. The subjects of experimental group were the students who took the courses in the second year of this study.

2. All the subjects received only one teaching method and were asked to take five examinations, including one pre-test (O₁ and O₆) and four post-test (O₂ ~ O₅ and O₇ ~ O₁₀). For both groups, the first test (O₁ and O₆) was to assess the ability which might confound this experiment. The following four tests (O₂ ~ O₅ and O₇ ~ O₁₀) were conducted to understand the development of the statistics learning procedure.

3. Subjects in control group received the traditional teaching method and in experiment group received the Scaffolding teaching method. The experiment group was given the treatment composed of some main steps, including instruction, simulation, teamwork, individual tests, and team recognition.

4. In order to rule out the contemporary history effect, the two groups were identical in all respects except for the different year for enrolling the university.

5. In order to rule out the testing confounding effect, the contents of pretest and the posttests were different and randomly selected from the test bank of the hospitality statistics modules.

6. In order to maintain the external validity, the experiment was conducted in the real teaching environments rather than the simulation one. In addition, students who participated in this project didn’t know they were in the experiments to avoid the Hawthorne effect. The students are from all over the Taiwan Island to assure the model of deliberate sampling for heterogeneity. The longitudinal data collection made this study without interactive effect. Both groups were taught statistics...
courses by same teacher with same textbook, classroom and all test items in order to avoid the experimenter effect (Cook and Campbell, 1979).

2. Statistical Methods

The Latent growth modeling, one of the statistical methods of structural equation modeling, was used for testing the research hypotheses. Data analysis was performed using the SPSS, AMOS and Excel package. An independent-samples t-test was performed to compare the pretest (Time 1) means of the experimental and control groups. A significance level of 0.05 was used to evaluate all hypotheses. Latent growth modeling (LGM) was further used to model development change of Statistics learning effectiveness among one year period. Duncan, Duncan and Strycker (2006) asserted that LGM is a potentially valuable methodology that many researchers will bolster successfully in identifying important predictors and correlates of change. It is able to test both linear and nonlinear growth functions and to decide which dependent variables affect the rate of development.

RESULTS

After 5 rounds data collection, all the data was examined the outliers and normality to do the further tests. The result was shown in Table 1. All modules of Skewness are less than two and Kurtosis is less than eight. These mean all the data meet the statistical hypothesis of single variable normality. In addition, the module of critical ratio (c.r.) are less than 10 fits the multiple normality model (Kline, 2011). An independent-samples t-test was performed to compare the pretest means of the two groups. The results showed no statistically significant difference between the two classes’ Statistics proficiency ($t = 2.28; p = .420$).

<table>
<thead>
<tr>
<th>Variable</th>
<th>min</th>
<th>max</th>
<th>skewness</th>
<th>c.r.</th>
<th>kurtosis</th>
<th>c.r.</th>
</tr>
</thead>
<tbody>
<tr>
<td>test1</td>
<td>31.00</td>
<td>86.00</td>
<td>.4110</td>
<td>1.6525</td>
<td>-.5571</td>
<td>-1.1200</td>
</tr>
<tr>
<td>test2</td>
<td>38.00</td>
<td>88.00</td>
<td>.5410</td>
<td>2.1752</td>
<td>.4871</td>
<td>.9792</td>
</tr>
<tr>
<td>test3</td>
<td>33.00</td>
<td>99.00</td>
<td>-.4888</td>
<td>-1.9655</td>
<td>-.4307</td>
<td>-.8658</td>
</tr>
<tr>
<td>test4</td>
<td>53.00</td>
<td>91.00</td>
<td>-.2510</td>
<td>-1.0093</td>
<td>.0914</td>
<td>.1838</td>
</tr>
<tr>
<td>test5</td>
<td>44.00</td>
<td>100.00</td>
<td>-.7018</td>
<td>-2.8216</td>
<td>1.9151</td>
<td>3.8501</td>
</tr>
<tr>
<td>Multivariate</td>
<td></td>
<td></td>
<td></td>
<td>4.6228</td>
<td>2.7209</td>
<td></td>
</tr>
</tbody>
</table>
The availability of a limited number of subjects raises the issue of generalizability of this study for external validity. More subjects from other universities will have to be included with testing done on more levels of colleges. This is a between-subject laboratory experiment. The two groups can be considered equivalent since all individual differences had been controlled for by ruling out the confounding variables. The differences in the responses of the subjects can be reasonably attributed to the differences in the independent variable. Therefore, internal validity is very strong.

In the experimental group, the mean value of Statistics learning effectiveness increased from 56.01 in time 1 to 77.78 over one year of observation. However, for the students in control group, the mean value of Statistics learning effectiveness varied irregularly from 40.00 in time 1 to 63.83. LGM was further used to model development change of Statistics learning effectiveness among one year period.

The results of LGM described a single individual’s developmental learning effectiveness and capture important group statistics parameters in a way that allows the research to understand the learning development at the group level. A series of LGM models were examined to determine viability of the cure of factors. Table 2 presents the estimating parameters for LGM. In sum, all the parameters are significant under the significant confidence level of 0.001. In the periods of scaffolding teaching, students got significant improvement on statistics learning effectiveness. After the last manipulation, students in experimental group continued to increase rather than students’ learning effectiveness decreased in control group.

The results indicated that students’ mean score of pre-test (Time1) is 56.14 in experimental group and the average improvement score is about 6.43. Over the year, 68% of the students got the scores between 44.47 and 67.81 and the improvement score is between 4.47 to 8.83. Regarding to the results of the variance and covariance, the score of pre-test (Time 1) was found to significantly do something with the improvement rate. The covariance of pre-test score impacted growth is -19.60. It means the lower score students got in the pre-test, the faster improvement they did over the one year Statistics learning.

In addition, this study examined the difference of Statistics learning effectiveness between both experimental and control group by using managing model in Structural Equation Modeling. Under comparison the nested models, the
hypothesis of all variances are equal is wrong (df=5; CMIN=289.04; P=.000<.001). In other words, there is significant difference of Statistics learning effectiveness between Scaffolding teaching and traditional teaching of Statistics learning in Hospitality Program.

<table>
<thead>
<tr>
<th>Symbols</th>
<th>statistic</th>
<th>sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept and Slope</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IMean Mean Score of the Pretest</td>
<td>56.14</td>
<td>***</td>
</tr>
<tr>
<td>Smean Average growth of five tests</td>
<td>6.43</td>
<td>***</td>
</tr>
<tr>
<td>Variance and Covariance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ivar Average score difference of pretest</td>
<td>136.42</td>
<td>***</td>
</tr>
<tr>
<td>Svar Average growth differences of five tests</td>
<td>3.83</td>
<td>.0013**</td>
</tr>
<tr>
<td>IScov Pretest score impacted growth</td>
<td>-19.60</td>
<td>***</td>
</tr>
<tr>
<td>Level 1 Variance of measure error</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E1 Measurement error of pretest</td>
<td>24.14</td>
<td>.0137</td>
</tr>
<tr>
<td>E2 Measurement error of test 1</td>
<td>111.06</td>
<td>***</td>
</tr>
<tr>
<td>E3 Measurement error of test 2</td>
<td>155.65</td>
<td>***</td>
</tr>
<tr>
<td>E4 Measurement error of test 3</td>
<td>120.23</td>
<td>***</td>
</tr>
<tr>
<td>E5 Measurement error of test 4</td>
<td>138.60</td>
<td>***</td>
</tr>
</tbody>
</table>

**DISCUSSION AND CONCLUSIONS**

While both experimental and control groups made significant gains in Statistics learning effectiveness during the one-year course, the experimental group had significantly higher learning effectiveness scores than the control group. Furthermore, the LGM showed Scaffolding teaching strategy helps students to get favorable reactions of Statistics learning for the students in Hospitality Program. The students perceived Scaffolding learning in Statistics as an active way to learn. Under the Scaffolding, they regarded learning statistics is a practical subject, and felt encouraged, respected, and motivated in the learning process.

This study makes some key contributions to the existing literature of learning
Statistics for the students in Hospitality Program. First, this study examined the Statistics learning effectiveness of Scaffolding learning upon the group receiving the strategy. Most important, it collected the longitudinal data rather than collected just one time survey or test. Longitudinal study can provide valuable information about trends and individual differences in aspects of change over time. Second, this study took advantage of the LGM to analyze and understood the individual differences of students in change which are often of scientific and practical interest (Preacher, et.al; 2008). Third, this study clarified the different types of learning effectiveness and learning styles during the two-year experiment. While many studies conducted the effectiveness of learning on Taiwanese hospitality management classes, these findings suggest the future research directions, including the relationship of cooperative learning, student characteristics, past achievement levels, learning styles and others. Finally, this study also developed the Scaffolding Module of teaching Statistics for the students in Hospitality program. The results did show it is better teaching strategy than the traditional one.

There are pedagogic research results which are essential for statistics teachers to stay informed about new findings. However, it is sometimes difficult to effectively apply them into the classroom. For example, Davis and Linn (2002) thought that the essence of the scaffolding metaphor may be compromised while it is applied broadly to any and all pedagogical practices. Some researchers questioned that scaffolding is better for one on one instructional activity rather than being used in a big class. On the other hand, this study did demonstrate the significant differences between Scaffolding and traditional teaching in Statistics. Hence, an essential component of applying research in the classroom is to change little by little.

Furthermore, it is easier to assess the impact of minor changes. Then, the further studies should pay more attention on the method of translating the notion of scaffolding to classroom learning, challenges for implementing scaffolding in classrooms environments, the key elements of applying Scaffolding to teach Statistics in the class.

LIMITATIONS AND SUGGESTIONS FOR FUTURE RESEARCH
The limitations of this study provide some directions for further research. Even though this study employed a relatively effective quasi-experimental method for the
analyses, as with any study in social science, the sample size and the design still may limit the generalizability of the findings drawn from this study. Generalizability of the findings should be done cautiously and cannot be generalized to whole population until results are replicated. Due to the difficulty of collecting the data with different schools or countries, the level of effects may not be generalizable to hospitality management program in other countries.

Even the study found out the differences between Scaffolding and traditional teaching statistics courses, applying the scaffolding theory to the teaching in big classes still been criticized. On the other hand, the sample size can be larger. Under this dilemma, the further studies should calculate the appropriate sample size which is suited to Scaffolding teaching intervention. In addition, they should be analysed to examine the extension validity of the scaffolding teaching in hospitality management programs. The further studies can compare the statistics learning effectiveness with other schools in the same or different countries under the ruling out experiment effect.

ACKNOWLEDGEMENT

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