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A STUDY ON E-LEARNING IN SMALL ONLINE DISCUSSION GROUPS AND EXPERIMENTAL DESIGN IN ADVANCED LEVEL BIOLOGY

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Abstract

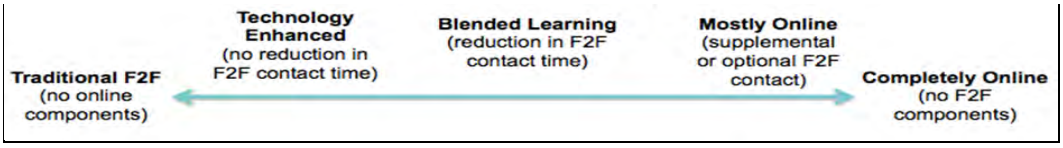
This pilot study focuses on assessing the effectiveness of discussion in small online student groups. Class discussions offer students opportunities to test their ideas and opinions against the ideas and opinions of their peers. More effective learning may be promoted through properly designed online discussion tasks. A class of 28 Advanced level Biology Students followed in this study were 16-17 years old at a pre-university college, where face-to-face learning is the norm. A two-week online course was designed to be followed in two steps: an ice breaker activity aimed at establishing an online learning community; a one-week experimental design program (EDP) designed to encourage discussion of experimental procedures in small groups of 4-5 students. The study was carried out during two one-week slots in 2017-18. Students' short term performance during the program and their long term performance when compared to a control group were analyzed. Several statistical tests were used to analyze the data using the facilities of SPSS. The Shapiro Wilk test was used to determine whether the score distributions violated the normality assumption. Since the score distributions satisfied the normality assumption, parametric tests were used to compare mean scores between various groups of students, where a 0.05 level of significance was adopted for each test. The Paired samples t-test was used to compare mean scores between pre- and post- EDP tests; the Independent samples t-test was used to compare mean scores between 'test' and 'control' groups; and the One-Way ANOVA test was used to compare mean scores between several classes. Moreover, 95% confidence intervals were computed to assess the variation in the mean scores if this study had to be replicated with other groups of students in the future.
Short term results showed that the EDP was effective in improving students' critical evaluation in experimental design procedures. However, though annual scores showed that the 'test' group mean was higher than that of the 'control' group, statistical analysis of these results, did not support any difference in achievement between the test and the control group.
Students' perception of this program indicates a number of positive and negative issues related to web-based learning also cited by the literature: the use of the discussion forum that permitted time to think about experimental design issues, different perspectives of colleagues to problem solving were positive issues while work overload and incorrect or insufficient feedback were some disadvantages mentioned.
Changes in science instruction, particularly biology, along with new digital learning opportunities may offer better approaches for future positive achievement among young people.

Keywords: *Web-based learning, online course design, small discussion groups, experimental design, biology teaching and learning.*

1. Introduction

Blended learning is a form of learning where traditional face-to-face (F2F) methods are combined with digital materials. Figure 1 shows a spectrum of various teaching methods from traditional F2F to the completely online method.

Figure 1.



"Hybrid" or "blended" are terms commonly used to describe courses that combine F2F classroom instruction with online learning. This allows the student much more flexible scheduling, while maintaining the F2F contact with the instructor and classmates that is typical of a more traditional course. As a general rule of thumb, courses in which fewer than 20% of the learning activities occur online are more likely to be labelled web-enhanced than hybrid (Hybrid courses, 2018). One of the challenges of technology enhanced courses that do not replace classroom activities with online activities is the 'course-and-a-half syndrome'. Course-and-a-half syndrome involves adding online components to a course without reducing any of the F2F instruction (Freeman & Trembl, 2013).

Effective blended learning considers the strengths of both the online and F2F environments and strategically incorporates activities that take advantage of the strengths in both environments. This involves rethinking the course design. Guidelines to avoid course-and-a-half syndrome, include redesigns that replace some 25% of F2F time with online activities (David O. McKay, 2018).

Advantages and disadvantages of F2F and completely online methods have been well documented (Qiuyun, 2011). Blended learning seeks to take advantage of the best of both traditional and completely online learning methods. However, the preferred mode of blended learning was not possible in this study for logistic reasons; instead an attempt was made to explore ways of introducing web based learning to students in discussion of principles of experimental design

Opportunities for class discussion are limited in a F2F environment. However, discussion is an important aspect of active learning and problem solving. Class discussions offer students opportunities to test their ideas and opinions against the ideas and opinions of their peers. Studies have shown that online discussion can be an effective tool to foster collaborative learning, provide more productive use of class time (Alkharusi, Kazem &Al-Musawai, 2010), as well as increase active learning .

The topic for discussion in this study was experimental design as this is the underlying process of scientific investigation. Students may recognize the general steps involved in scientific investigation but often have only a surface understanding of the process. Hands-on experience in the design of experiments has been widely recognized as an effective means of teaching principles of experimentation and as a critical component of undergraduate science education (Adams, 2009).

In the early stages of the biology programme at Junior College (JC), where F2F learning is the norm, 16-18 year-old students, studying Advanced Level Biology complete the first part of a 'hands-on' laboratory set of practical sessions in which they design and conduct their own experiment before answering questions on a worksheet relating to the analysis of the data and interpretation of their results. As they progress through their studies, there are opportunities to design experiments in subsequent practical sessions. However, students struggle to design their experimental procedures, possibly because there is little time for discussion of their procedures. The following pilot study focused on assessing the effectiveness of online discussion in terms of JC students' understanding of principles of experimental design as currently expected by the Advanced Matriculation Biology syllabus (Malta)

2. Aim, purpose of research & materials used

1. To initially establish an online learning community of 28 Advanced Level Biology Students by designing an online VLE 'icebreaker activity' programme
2. To design and assess a subsequent online one-week programme for small groups of 5-6 students
3. To assess the effectiveness of resulting online discussion groups, compared to a control group of 227 students

2.1. Materials

Two Online programmes were designed for the purpose of this study based on principles followed at ION in 2015;

Cluster sampling was used, where a class of 28 first year (2017-2018) students taking Advanced Level Biology participated in these programmes.

3. Methodology

The study was carried out in two main steps, each including an online programme involving the discussion forum.

Step 1: The online VLE introductory programme was available to all 28 students after a F2F introduction to familiarize students with the use of the discussion forum.

Step 2: The Experimental Design Programme (EDP) was available to students from the 9th to the 17th March 2018, where the 28 students participating in the course were split up into six groups of four or five.

Within the group, a student was expected to participate as follows:

i. Read recommended online resources and choose one of 5 questions on experimental design (from AM past paper 4) by the 10th March
ii. Post their first response by the 12th March.
iii. Give feedback to at least two other participants within the group from the 12th to the 15th March
iv. Post their second revised response by the 17th March
v. Finally post their reflection activity on the 17th March, to conclude the programme.

During this week, each half of the class had their weekly tutorial hour replaced by a two- hour computer lab session to partially replace F2F time with online activity time. The facilitator's role during the course was to give feedback to students as necessary, taking care not to take the central role but rather to be a 'guide on the side' of the various threads of discussion in the forums.

In the EDP, the assessment mark/score obtained by students in their first post and in their second post was recorded for all 28 students.

Several statistical tests were used to analyse the data using the facilities of SPSS (Statistical Package for Social Science) version 24. The Shapiro Wilk test was used to determine whether the score distributions violated the normality assumption. Since the score distributions satisfied the normality assumption, parametric tests were used to compare mean scores between various groups of students, where a 0.05 level of significance was adopted for each test. The Paired samples t-test was used to compare mean scores between pre- and post- EDP tests; the Independent samples t-test was used to compare mean scores between the 'test' and 'control' groups; and the One-Way ANOVA test was used to compare mean scores between several classes. Moreover, 95% confidence intervals were computed to assess the variation in the mean scores if this study had to be replicated with other groups of students in the future.

4. Results

a. Short term results of EDP

The paired samples t- test was used to compare mean scores between first and second post during the EDP. This programme was followed by 26 of the 28 students in the class. The null hypothesis specifies that there is no difference in the mean scores between first and second posts and is accepted if the P-value exceeds the 0.05 level of significance. The alternative hypothesis specifies that there is a significant improvement in the mean scores between first and second posts and is accepted if the P-value is less that the 0.05 criterion.

Table 1 shows that the mean score in the second post (7.79) exceeds the mean score in the first post (6.69) by 1.1 points and this difference is significant since the P-value (approx. 0) is less than the 0.05 criterion. Hence it can be generalised that the EDP was effective in improving students' critical evaluation in experimental design procedures, in the short term.

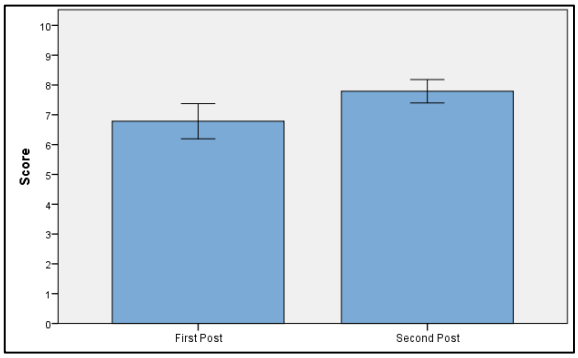
Table 1. Results of Paired Samples t-test showing mean assessment marks of the first post and second post during the EDP, Standard Deviations and P-value.

Paired Samples T-Test

	Mean	Sample size	Std. Deviation	P-value
First Post	6.69	26	1.517	0.000
Second Post	7.79	26	0.971	

The fact that the two confidence intervals (Figure 2) are disjointed (do not overlap) explains why the Paired samples t-test yielded a significant difference in the mean scores between the two postings.

Figure 2. Error Bar Graph of mean scores for first post and second post that displays the 95% confidence interval of actual mean scores if this study had to be replicated with other groups of students in the future.



b. Long term results of EDP

The independent samples t-test was used to compare 'test' and 'control' group results in pre- and post-EDP test scores.

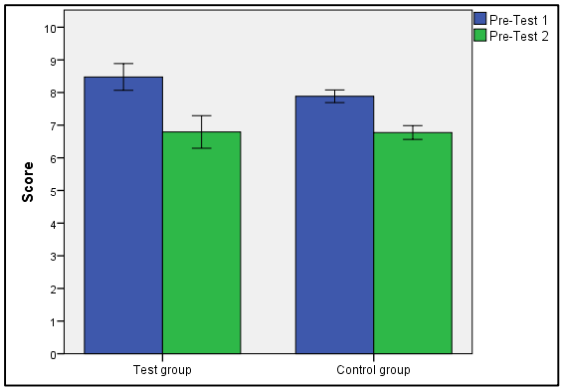
i) Comparison of pre-test scores:

Table 2. Comparison of 'test' group and 'control' groups mean scores in practical tests involving experimental design procedures before the online EDP using Independent Samples t-test showing mean scores for two pre-tests (1 and 2), sample sizes, standard deviations and p-values.

Independent Samples T-Test

	Group	Sample size	Mean	Std. Deviation	P-value
Pre-Test 1	Test group	27	8.20	1.749	0.219
	Control group	227	7.82	1.489	
Pre-Test 2	Test group	27	6.68	1.338	0.782
	Control group	212	6.77	1.539	

Table 3. Error Bar Graph displaying 95% confidence intervals of the mean pre- tests 1 and 2 scores for the 'test' and 'control' groups.



Output of Independent samples t-test for scores of pre-EDP test 1 and 2: the mean scores vary marginally between the 'test' and 'control' groups; differences between the two groups are not significant since the p- values exceed the 0.05 level of significance (Table 2). This result is complemented by the error bar graph (Table 3) since the 95% confidence intervals overlap. There was no significant difference between the 'test' and 'control' groups of students before the online programme.

Comparison of post-test scores following the online (EDP) programme:

Post-EDP test Scores obtained by students in the Annual Biology Exam (June 2018) Question (Paper one Number 8) involving knowledge of experimental design were compared to find if there was any significant difference between the different Biology classes using the One-Way ANOVA test.

The 'test group' in this study refers to the '4B' class that followed the online experimental design programme, while all the remaining first year (2017-2018) Advanced biology classes pertain to the 'control' group.

The One-Way ANOVA test was used to compare mean scores between the advanced biology classes and this was carried out for two separate pre-EDP tests (November 2017 and March 2018)

The null hypothesis specifies that the mean scores vary marginally between the classes and is accepted if the P-value exceeds the 0.05 level of significance. The alternative hypothesis specifies that the mean scores vary significantly between the classes and is accepted if the P-value is less than 0.05 criterion.

Table 4. Comparison of mean scores between classes in post-(EDP) test question involving experimental design procedures after the online experimental design programme using the One-Way ANOVA test showing mean scores, sample sizes, standard deviations and p-value.

Classes	Sample Size	Mean	Std. Deviation	P-value
3A	27	9.519	1.5657	0.975
3B	25	9.660	1.7061	
4A	25	9.520	2.1817	
4B (test group)	28	9.964	1.9904	
5A	27	9.852	2.3197	
5B	28	9.464	2.0364	
6A	29	9.707	1.4238	
6B	29	9.707	1.4238	

Table 5. Error Bar Graph displaying 95% confidence intervals of the mean post-test scores for all classes (4B is the test group).

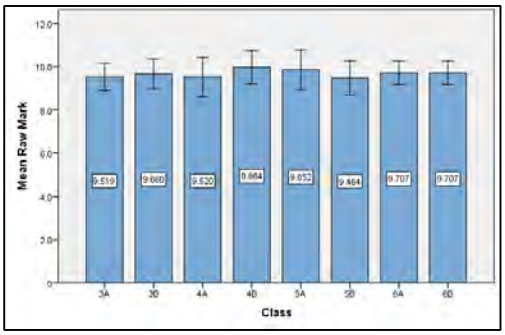


Table 4 shows that though the 'test' group (4B) obtained the highest mean score (9.964) in this cohort, there is no significant difference in the mean scores between the different classes. The error bar graph (Table 5), displaying the 95% confidence intervals of mean scores, shows that these confidence intervals overlap considerably complementing the result of the One-Way ANOVA test.

a. Reflection Activity

Twenty-three students out of twenty-six submitting their reflection.

Students' perspective of positive aspects of EDP included: 1. Gaining confidence in tackling experimental design issues; 2. Chance to view different perspectives to problem solving by class mates; 3. Giving and receiving feedback from classmates/teacher.

Negative aspects of EDP included work overload, feedback from colleagues not always correct, final procedure was not carried out in the lab.

5. Discussion, conclusion and recommendations

The results of this study showed that students' performance in tackling their experimental design improved significantly by the end of the one week. Results of paired t- test show a significant difference in the scores obtained. (Table 1; Figure 2)

However, though annual results in a question related to experimental design showed that the test group mean was higher than that of the control group, statistical analysis of these results did not support any difference in achievement between the test and the control group (Table 4 &Table 5)

These results indicate that in the short term, the online discussion activity did help students to improve their performance in experimental design questions but this advantage was lost in the long term i.e. at the end of the academic year. Changes in science instruction, particularly biology, along with new digital learning opportunities may offer better approaches for future positive achievement among young people.

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