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ODL: Online Distance Learning of Quantitative Courses in Higher Education

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ABSTRACT

The study examined a new asynchronous model for online learning of quantitative courses in higher education, which is a complete substitute for face-to-face learning. The model is called ODL (Online Distance Learning) and is based on a combination of the following successful previous models:
CTBL: Comprehensive Technology-Based Learning (Ghilay, 2017).
FBL: Feedback Based Learning (Ghilay & Ghilay, 2015a).
OTLA: Online Teaching, Learning and Assessment (Ghilay & Ghilay, 2013).
The study is based on two samples of students who attended college and participated in an ODL-based course $(n_1 = 37)$ and face-to-face learning of the same course $(n_2 = 67)$. Students who participated the ODL course, were asked to answer a questionnaire focused on three areas: the course components, characteristics of learning process and time investment. Besides, achievements of the ODL course were compared to the same course in a face to face format. The research reveals that according to students' views, the new model is very helpful for their studying process. Beyond that, it was found that achievements in the ODL course were at least equal to those of a face-to-face course. The results indicate that it is worthwhile to adopt the new model in institutions of higher education.

Keywords: ODL; CTBL: Comprehensive Technology-Based Learning; FBL: Feedback Based Learning; OTLA: Online Teaching, Learning and Assessment; online learning; computerised assessment; LMS: learning management system; asynchronous learning.

INTRODUCTION

The new model

The study examined an asynchronous model for online distance learning of quantitative courses in higher education. The new model is called ODL (Online Distance Learning) and it is a complete substitute for face-to-face learning. It is based on a combination of the following three successful models:

1. CTBL: Comprehensive Technology-Based Learning (Ghilay, 2017).
2. FBL: Feedback-Based Learning (Ghilay & Ghilay, 2015a).
3. OTLA: Online Teaching, Learning and Assessment (Ghilay & Ghilay, 2013).

CTBL: Comprehensive Technology-Based Learning

Comprehensive Technology-Based Learning (CTBL) improves learning in hierarchic knowledge-based quantitative courses such as computer technology and mathematics where mastery of current topics depends upon mastery of previous ones. When gaps in students' knowledge occur, they are difficult to overcome, making progress arduous. As gaps widen, learning becomes more and more onerous often culminating in loss of the learner's connection with the course (Ghilay, 2017).

This model offers a comprehensive package featuring wide coverage of all course material. It is designed to provide solutions in real-time to deal with the occurrence of knowledge gaps. The

model's educational outlook fosters the learning processes of all learners regardless of administrative issues. Learners may avail themselves of whatever suits their learning style, preferences and specific difficulties. The integration of technology provides a richer learning experience and greater opportunity to meet student needs. Combination of CTBL in ODL, includes all CTBL's components except for face-to-face meetings (Ghilay, 2017). The coverage the model provides includes:

1. *Text*: Full textual coverage of the material including answers to exercises. It is always possible to review all the material including exercises and solutions.
2. *Video*: Video clips provide full coverage of all theoretical material and exercises. To assist students with difficulty in solving a question, a link to a video showing the solution is provided at the end of the question. Solutions to all exercises can be created through video capture technology.
3. *Feedback questionnaires*: To ensure that what each theme has been thoroughly assimilated, the FBL (Ghilay, 2017; Ghilay & Ghilay, 2015a) is used to transfer student feedback to the lecturer at the end of each topic. Every problematic issue receives a relevant answer from the lecturer (or the tutor), until all irregularities have been resolved.
4. *Answering questions*: Each student is invited to ask questions about troubling issues and to get answers within a reasonable time, via remote communication with the lecturer or tutor (including remote control of students' computers, if required).

Research findings show that CTBL model significantly improves the learning experience in a quantitative course. Possible explanations for this may be: Flexibility, comprehensiveness (the variety and coverage of material), the ability to overcome knowledge gaps, and the excellence of the learning experience (Ghilay, 2017).

FBL: Feedback-Based Learning

Promoting student success in learning has become an issue of concern among educators all over the world (Elton & Johnston, 2002; Knight & Yorke, 2003; Marton & Booth, 1997; Marton & Saljo, 1997; Prosser & Trigwell, 2001; Race, 2005; Ramsden, 2000). Substantial numbers of students come into a class with all the appropriate prerequisites yet they are incapable of handling the course material (Wilson & Scalise, 2006). The usual explanation for student difficulties is that students do not study enough or they are not interested (Hesse, 1989). In light of the fact that communication between faculty and students is a critical element of higher education, effective feedback (Felder & Brent, 2004) may be the missing component in successful outcomes. Higher education will not be significantly improved, Burksaitiene (2011) argues until the feedback system is changed.

In order to be effective, feedback should close the gap between students' actual performance level and the level required by lecturers. Efficient feedback gives specifics regarding shortcomings (Hattie and Timperley, 2007): Does the information imparted in the critique help students close the gap between current knowledge and the program's desired outcomes? (Croton, Willis & Fish, 2014). Providing such feedback is not an easy task.

Yet international research indicates that students respond very well to feedback delivered in digital form. A meta-analysis of more than 7,000 studies (Hattie and Timperley, 2007) reveals that multimedia feedback is one of the most effective ways to obtain positive results from feedback.

The Feedback-Based Learning model (Ghilay, 2017; Ghilay & Ghilay, 2015a) confronts the challenge of getting institutions of higher education to appreciate the validity of students'

learning experience. It provides immediate student responses to lecturers' practice via use of personal smartphones (or tablets/laptops) to online questionnaires concerning the delivery of the educational program. It informs lecturers how each subtopic has been understood and implemented by all students in the course. This enables instructors to respond in real time to student difficulties either by explaining topics over again or by discussing unclear issues. The feedback effect is achieved by:

1. Having each student answer an online questionnaire that has been prepared by the lecturer querying understanding of all subtopics in a main theme at the end of every main topic.
2. The format of a feedback questionnaire is presented in Figure 1.

Figure 1. The questionnaire format.

Topic no. X: Topic's Name

To what extent did you understand and assimilate the issues studied in topic number x? (1-Very little, 2-Little, 3-Medium, 4-Much, 5-Very much).

Subtopic	1	2	3	4	5
A					
B					
C					
D					
E					
…					

Additional remarks relating to topic no. x.

If relevant, please mention additional notes relating to the learning process of topic no. x, especially, understanding and assimilating the material.

_____

_____

_____

_____

Student name: _____

3) Based on the questionnaire's results, the lecturer should assist students concerning their difficulties in specific subtopics.

To McAleese et al. (2013), institutions of higher education should encourage, welcome, and take account of student feedback which could detect problems in the teaching and learning environment early on and lead to better improvements. FBL meets this challenge by enabling faculty to consistently monitor student progress and intervene when required. Underlying the model is the availability of real-time continuous diagnosis and prognosis carried out during the learning process. The model is particularly suitable for hierarchically structured courses in which understanding of each topic depends upon knowledge of a prior topic. When students accumulate gaps in knowledge, understanding subsequent themes becomes more challenging.

OTLA: Online Teaching, Learning and Assessment

The OTLA Model (Online Teaching, Learning, and Assessment) is a means for creating full online asynchronous distance learning. It is based upon LMS (Learning Management System) such as Moodle combined with other technological tools.

Examined in institutes of higher education, the model was found to be useful for multi-text courses (Ghilay, 2017; Ghilay & Ghilay, 2013). However, with certain supplements, such as combining it with CTBL and FBL (mentioned above), it can be applied to quantitative courses as well.

For each course, there is an LMS website which is divided into main topics and is open to registered students only. For quantitative courses, OTLA includes the following digital components (Ghilay, 2017):

1. *Text*: All relevant documents are included on the course website, created in Learning Management System (LMS) such as Moodle. All texts are in pdf format (including relevant links), enabling them to be read on screen, printed out, searched or saved. Texts are divided into main topics.
2. *Hypertext*: The pdf documents and LMS pages include relevant links leading to relevant supplements such as additional texts or recorded lectures (video clips, audio files, etc.).
3. *Lectures* (video): Each topic is accompanied by a video lecture recorded in "lab conditions," i.e., not a live lesson. This is more effective because there is no time-wasting or audience disturbance. Video is especially suitable for courses in which it is essential to "see things" during the lecture: formulas, mathematical expressions, diagrams, etc. Video files are uploaded in HD resolution to a video-sharing site such as YouTube and linked to the course website.

   A recorded lecture is an asynchronous replacement for a live lecture given in a classroom. It is worthwhile to divide a video lecture into small portions so as to allow subtopics to receive their due emphasis.
4. *Exercises*: Both optional and compulsory exercises are enabled in the OTLA model. Optional exercises give students practice in the skills entailed in a certain topic. While optional exercises are not included in the final score, compulsory exercises are summative assessments that receive a certain weight in the final grade. Compulsory exercises can have a time limit for submission or permitted time durations.
5. *Final computerised exam*: The final exam can be given in class or at home and is similar to the compulsory exercises containing questions not given before.

In addition to the technological components, the OTLA model includes lecturer involvement in the whole learning process. The lecturer has intensive daily participation in what students do and how they advance. It includes continuous monitoring of student progress as well as giving assistance in real-time relating to both academic and technical issues.

To prepare, run or update a course based on the OTLA model, lecturers need to be familiar with online learning technologies: LMS (Moodle or equivalent), pdf applications, hypertext, video capture, Computer Assisted Assessment (CAA) and techniques for remote control of computers (for supporting students if necessary).

Description of the new ODL (Online Distance Learning) model

The new ODL model offers a comprehensive package for online distance learning of quantitative courses, based on a combination of CTBL (Comprehensive Technology-Based Learning), FBL (Feedback-Based Learning) and OTLA (Online Teaching, Learning and Assessment) mentioned above. It includes the following major components:

1. *Lectures*: Video clips cover comprehensively all theoretical topics. Each clip is short and relates to a specific subtopic.
2. *Texts*: Texts cover in detail all course contents. Students can always review all themes including exercises. All texts (theory and practice) consist of links to relevant video clips. Such links also exist on the main page of the course website.

3. *Exercises*: Optional and compulsory exercises are presented on the course site (as described in OTLA model). The optional exercises are used as a tool for formative evaluation, so their marks are not included in the course grade. On the other hand, the compulsory exercises combine formative and summative assessment, and as such, students can be allowed to re-submit them for improving their grade. Both types of exercises include a link to a video solution for each question. Solutions for compulsory exercises are presented only after the last date of submission. Before the end of each semester, a summary exercise and a practice test are presented (including video solutions for each item).
4. *Lecturer involvement*: The lecturer should participate on a daily basis in what students do and how they advance. It includes two major types of activity, proactive and reactive: *Proactive involvement:* It relates to two main characteristics:
    - *Basic monitoring*: It should be checked that each student enters the relevant items on the course site and submit exercises, in accordance with the timetables set. The lecturer should immediately respond to any deviation.
    - *Advanced monitoring based on online feedback*: To ensure that each topic has been thoroughly assimilated, the FBL (Ghilay, 2017) is used to transfer student feedback to the lecturer during the whole learning process. All problematic issues should receive a quick reply.

Reactive involvement: Each student is invited to ask questions about problematic issues (academic or technical) and receive answers quickly and efficiently.

5. *Summative assessment:* The final computerised exam is similar to the exercises and it covers all major topics of the course. Appropriate submission of all types of exercises (optional, compulsory, summary, practice tests, etc.) is intended to be a suitable preparation for the final evaluation.

The study framework: examining ODL model

A course of PSPP (statistical software equivalent to SPSS) was taught at the NB School of Design and Education. The course included the following topics: descriptive statistics, syntax, computerised variables, case selection, T-test, ANOVA, crosstabs, chi-square, reliability (Cronbach's alpha), item analysis and factor analysis. This one-year course was taken by third-year students in the School of Management and Economics at the NB School of Design and Education.

The course was given in two formats:

- 2016-2017 (one year): Online distance learning based on ODL $(n_1 = 37).$
- 2010-2016 (six years): Traditional face-to-face format $(n_2 = 67).$

In each of these seven years, the course was given by the same lecturer and included the same content and similar requirements.

Respondents taking the course during 2016-17 answered a questionnaire focusing on their attitudes toward online distance learning based on ODL.

The second part of the study included a comparison between the achievements of students in online distance learning (ODL) and their achievements in traditional face-to-face learning, as detailed below.

METHOD

The research questions

The research questions intended to measure the effectiveness of ODL in higher-education institutes.

The following research questions were worded:

1. How do students perceive inputs (video clips, lecturer involvement, exercises and texts), the learning process (flexibility and convenience and effectiveness) and time pressure in an ODL course?
2. Is there a significant difference in students' achievements in ODL compared to face-to-face learning?

Population and Samples

Population: The population addressed through the study included all students at the N.B School of Design and Education studying in online distance learning.

Samples: Relating to students' perceptions (the first research question), there was one sample including 37 students who studied the course based on ODL.

Concerning students' achievements (the second research question), there were two samples including 37 students who studied the course based on ODL and 67 students who studied the same course in a face-to-face format.

Tools

Questionnaires

At the end of 2016-2017, students were asked to answer an online questionnaire on a five-point Likert scale that included 31 items. The questionnaire also included an open-ended question focusing on the advantages/disadvantages of the model over face-to-face instruction, as follows:

> *Are there any additional advantages/disadvantages to ODL beyond what has been mentioned earlier?*

The questionnaire was anonymous, and the rate of response was 100% (37 out of 37).

Data Analysis

The following seven factors, divided into three main groups were examined:

Comments:

- For each factor, all the items composing it are presented (questions that appeared in the questionnaire). High reliability was found (Cronbach's alpha) as indicated in parentheses.
- Factor scores were the means of the items composing them.

1) Inputs:
   - Video clips: (Alpha = 0.813):
     - Watching the video lectures is helpful for learning
     - Video clips including solutions of exercises are helpful for learning
     - I use to watch the video lectures
     - The video clips were helpful

   - Lecturer's involvement (Alpha = 0.703):

- Getting assistance from the lecturer is possible
- I got help from the lecturer during the course

- Exercises (Alpha = 0.787):
  - Optional exercises are helpful
  - Mandatory exercises are useful
  - The required activities reflected my knowledge
  - Optional exercises are a good preparation for the mandatory ones

- Texts: The texts in the course website are clear and understood

2) Learning process:
   - Learning flexibility and convenience (Alpha = 0.841):
     - Studying in an online distance course is convenient
     - An online distance course has great flexibility
     - The option to study when I wish is helpful
     - The opportunity to submit exercises when I wish is useful
     - Online distance learning saves time
     - I enjoy online distance courses
     - There is flexibility regarding exercise submission dates
     - Studying in an online distance course is easy
     - I can ask the lecturer questions anytime and get answers

   - Learning Effectiveness (Alpha = 0.794):
     - I had a successful learning experience
     - Due to the course design I was able to progress throughout the whole semester
     - I prefer an online distance course
     - Towards the end of the semester, I felt ready for the exam
     - I had no difficulties with online distance learning
     - The learning process in an online distance course is effective
     - I expect to obtain a high grade in the course
     - I am not afraid of failing the course

3) Time:
   - Time pressure (Alpha = 0.800):
     - I invest much time in an online distance course
     - There is time pressure in the course
     - Time pressure in the course disturbs me

For each factor relating to the first two groups (inputs and learning process), Paired Samples T-test (0.05) was conducted for checking significant differences between pairs of factors.

Comparison of achievements

Regarding the second research question, the average grade of students was calculated for 2010-2016 (face-to-face) and 2016-2017 (online distance learning). In addition, an Independent Samples T-test (0.05) was also conducted to determine whether there were significant differences between the mean scores of these two groups.

RESULTS

Mean factor scores are presented in Table 1:

Table 1. Characteristics of ODL.

Groups	Factor	Mean	N	S.D
Inputs	Video clips	4.59	33	.39
	Lecturer involvement	4.50	33	.43
	Exercises	4.32	33	.39
	Texts	4.10	30	.84
Learning process	Learning flexibility and convenience	4.28	33	.48
	Effectiveness of the learning process	4.22	33	.40
Time	Time pressure	4.00	33	.56

According to the findings, learners perceive ODL to be effective for all three categories:

1. *Inputs:* Students rate all ODL inputs with high scores. The contribution of the video clips (4.59), lecturer involvement (4.50), exercises (4.32) and texts (4.10) is substantial.

   There was significant difference between the following factors:
   Video clips (4.59) and exercises (4.32): $t_{(32)} = 5.301,\ p = .000$.
   Video clips (4.59) and texts (4.10): $t_{(29)} = 5.301,\ p = .007$.
   Lecturer's assistance (4.50) and texts (4.10): $t_{(29)} = 2.333,\ p = .027$.

2. *The learning process:* Flexibility and convenience of learning (4.28) and the effectiveness of the learning process (4.22) are rated as very effective. There was no significant difference between these two factors $(t_{(32)} = 1.033,\ p = .310)$.

3. *Time:* Time pressure is quite reasonable (4.00).

The open-ended question strengthens the closed statements as shown in the following quotes:

"I got along with all the subjects very well. All topics were interesting and easy to understand. What helps me the most are videos (lectures and exercises solutions) ".
"Thanks to the lecturer for everything, for his great help and support, and especially for his patience ".

The above quotes highlight what is also found in the quantitative part of the study: the comprehensive video coverage and its great contribution to the understanding and assimilation of the course topics, as well as the significant influence of the lecturer's involvement.

Relating to the second research question, Table 2 compares the mean grades during the period 2010-2016 (face-to-face learning) and 2016-2017 (online distance learning based on ODL model).

Table 2. A comparison of achievement in face-to-face learning and online distance learning (ODL).

Course	Year	Mean	N	S.D	T-test
Face-to-face (six cohorts)	2010-2016	82.18	72	11.39	$t_{(103)} = .435,\ p=.664$
Distance learning-ODL (one cohort)	2016-2017	83.18	33	1.72	
Overall		82.50	105	10.90	

The T-test shows that there was no significant difference in student achievement in both learning formats, namely, course grade is stable over seven years, regardless of the form of learning. Assuming a similar level of student ability in both groups (the threshold for admission was not changed), the conclusion is that online distance learning based on ODL model does not adversely affect learning achievement.

CONCLUSION

ODL's asynchronous model is a complete substitute for the face-to-face learning of quantitative courses. It should be noted that often, quantitative courses are quite difficult to learn because they have a hierarchical structure. The reason for this phenomenon is that almost every topic studied depends on prior knowledge. As such, distance learning of quantitative courses is definitely not an easy task. Therefore, if an effective method for online distance learning of quantitative courses would have been found, it could be a strategic tool for institutions of higher education. The administrative benefits of distance learning are known and understood. It is quite obvious that online distance learning has clear organisational advantages over face-to-face learning for all stakeholders involved. Both the faculty and students enjoy the benefits of saving resources (classrooms, time, electricity, transportation, etc.) and not being dependent on time and place. All these advantages are obvious and the overall gain depends on the ability to maintain academic level which is at least equal to that of traditional learning. If the academic aspects of online distance learning are not inferior to traditional learning, then the worthiness of adopting the new model is significant.

The findings of the ODL study show that from an academic perspective, this can be a great way to study such courses in higher education. As Mayer (2009) claims, one of the main challenges in e-courseware is how to adapt technology to aid human learning. In fact, the ODL model is able to create an effective connection between specific learning needs and technology.

One of the striking findings of the study is that ODL allows students to achieve what they need mostly, especially for quantitative courses - effective learning and flexibility. An important reason for achieving this goal might be the comprehensive use of videos covering the whole curriculum.

The significant advantage of video clips compared to reading texts was previously found in face-to-face computer courses (Ghilay & Ghilay, 2015b). The new study provides evidence that this benefit is also valid for online distance learning of quantitative courses. It means that the use of video for learning has significant added value compared to text only. This finding is crucial to online distance learning, where video lectures and exercises are a substitute for face-to-face meetings.

The other main reason for this success is the effective and intensive involvement of the lecturer while running an online distance course. This type of involvement is much more focused and efficient than traditional lecturer activity, because the efforts of the instructor are primarily directed at the students' real needs and difficulties.

It is quite clear that in the short term, the preparation of such a course is very demanding and requires much harder work than traditional learning. On the other hand, it is likely that the better the training tools, the more the lecturers will be able to reduce their involvement during learning. In other words, a large investment in the short term is expected to bear fruit in the long run.

Moreover, the research reveals that the new model is effective not only as a result of student satisfaction. This conclusion is supported and sustained by real outcomes, namely, students' achievements. The study provides evidence that ODL achievements are not inferior to traditional learning. According to the literature, an online distance learning which is equivalent to conventional instruction in terms of learning outcomes, is considered a success if it provides learning online without sacrificing student achievement (Means et al., 2010). In fact, the study provides significant evidence that students' ODL performance is not inferior to traditional learning. This finding strengthens the research and gives it more validity.

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