VIDEO-BASED LEARNING OF QUANTITATIVE COURSES IN HIGHER EDUCATION

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ABSTRACT

The aim of the study was to examine the effectiveness of a model called Video-Based Learning (VBL). VBL is designed to improve the learning of higher education courses, especially those based on activities performed on a computer screen, or learning related to the understanding of visual objects, such as formulas, equations, diagrams, etc. The present study aims to examine the effectiveness of the model for quantitative courses, such as statistics, mathematics, computer courses, or equivalent. The research was based on six samples of students (n_1=14, n_2=41, n_3=17, n_4=27, n_5=27, n_6=19, n_{total}=145) who studied three quantitative courses: Fundamentals of PSPP, Introduction to Statistics, and Math for Business Administration. The learners were asked to answer an online questionnaire to assess the characteristics and advantages of VBL for their studies. The findings of the study indicate that according to the students' perceptions, VBL has a significant advantage for students' learning in quantitative courses in higher education: The learning process is outstanding and is much better than reading texts or listening to live lectures and it is considerably flexible. Therefore, it is recommended to adopt the model in faculties of higher education teaching quantitative courses.

Keywords: Screencast, Video-Based Learning (VBL), Quantitative Courses, Higher Education, Statistics, Mathematics, Computer Courses, Video Capture, Video Clips, Learning, Screen Casting.

INTRODUCTION

General Background

Video is an excellent technology for online learning, especially, as an asynchronous replacement or supplement for face-to-face learning. There are two main ways for producing video clips: using a camera or by unique technology called video capture/screencast (Ghilay, 2018; 2017a; 2017b). The study was focused on examining the effectiveness of a model called Video-Based Learning (VBL), for quantitative courses. The model is based on producing clips by video capture technology, covering the whole course curriculum. It is designed to improve the learning of higher education courses, especially those based on activities performed on a computer screen, or learning related to the understanding of visual objects, such as formulas, equations, diagrams, etc.

Video capture is a special way designed for producing video clips of a presenter's computer screen and it can be combined with the guide's audio narration. The screen activity is recorded in real time whereas the complementary audio can be recorded at the same time or separately with the addition of different effects and/or music. During the editing stage, additional changes can be undertaken including splitting and merging sections, hiding and exposing parts of the screen or adding photos, titles or subtitles (Ghilay, 2018; 2017a; 2017b). Video capture is an exceptional substitute to video camera recording and it can give learners even more dynamic and exciting contents (Ruffini, 2012). Furthermore, since the clips can be stopped or reviewed anytime, anywhere, (Screencast, 2014) learners can advance at their own speed which is helpful for improving the learning at the institute of higher education or even outside the classroom.

Currently, instructors in lots of disciplines use video capture technology for guiding purposes in topics, such as computer programming languages (Yuen, 2007) instructional design and technology (Sugar, Brown, & Luterbach, 2010), object-oriented programming (Lee, Pradhan, & Dalgarno, 2008), mathematical modeling (Ellington & Hardin, 2008), nursing (Phillips & Billings, 2007), and more. These video lectures show specific actions associated with a specific content area.

Using video capture for learning is significantly advantageous (Peterson, 2007). The enormous increase in the use of smartphones and tablets allows students to watch useful videos while overcoming time and location constraints (Ghilay, 2018; Campbell, Grossman, Kris, Kazer, & Rozgonyi, 2010).

Video capture clips can be an adequate substitute to face-to-face lectures (Pang, 2009; Traphagan, Kucsera, & Kishi, 2010) and there is clear evidence to general advantages of using such means for student learning as a replacement to other ways of studying (Campbell et al., 2010; de Koning, Tabbers, Rikers, & Paas, 2007; Gardner, 1983; Mayer, 2009; Smith & Smith, 2012; Walker, 2010).

Hartsell and Yuen (2006) claim that online video-based instruction "brings courses alive by allowing online learners to use their visual and auditory senses to learn complex concepts and difficult procedures" (p. 31).

According to Mayer's (2009) multimedia learning theory, animated presentations with audio narration provide a better learning experience than a combination of stills and text. This corresponds to Paivio's (2007) dual encoding theory, where information is processed using separate input channels, which improves the learning experience. By presenting a trained instructor who performs and explains a task, screencasts provide these multiple input channels (Wouters, Paas, & van Merrienboer, 2008).

Learners in online learning environments rely profoundly on 'learning objects', reusable digital resources that are integrated into a lesson or group of lessons assembled into units, modules, courses, or programs. These resources can take the form of electronic text, a simulation, a website, a graphic image, a movie, etc.

The diversity of resources in learning with technological assistance (McGreal, 2004) plays in Mayer's (2009) 'learning-preferences hypothesis,' which states that information presented in different formats serves the learning preferences and learning styles of students. A method that combines voice and visualization turns to a greater variety of learning styles than information presented only through text and images (Gardner, 1983). Video screen capture augments live lessons with multimedia lessons, itself becoming a cognitive tool that supports, guides, and mediates the cognitive processing of learners (Kong, 2011).

A multimedia program can be available to students outside of school in the form of a flipped class; that is, learning principles at home using screencasts and then getting guided practice in the classroom (Smith & Smith, 2012).

Smith and Smith (2012) also found that students who studied Computer-Aided Design (CAD) by watching video clips, got significantly higher marks than those who studied the same contents using traditional textbooks. Walker (2010) achieved similar results for the statistical functions of Excel.

It should be stressed that the use of video capture technology does not require significant investment in technological infrastructure or in software development teams. Every lecturer needs to learn the educational and technical aspects of video capture and then with minimal equipment, a personal computer and microphone, suitable software and access to LMS and file-sharing sites such as YouTube or Vimeo experiment with the technology (Ghilay, 2017a).

Many screencast programs exist and they vary in features and cost. Tools are divided into two main groups:

1) Free tools: Jing, Screenr, Screencast-o-Matic (PC only), CamStudio, and Community Clips (PC only).

2) Commercial tools: Camtasia Studio, iShowU, HD Pro, Adobe Captivate, and ScreenFlow (Ghilay, 2017a).

1. Video-Based Learning (VBL)

Video-Based Learning (VBL) is a method in which a course syllabus is fully covered by video clips (not exclusively),

either as a replacement or supplement to live lectures. The comprehensive coverage should include at least all the lectures, but it may cover solutions to the course exercises as well (Ghilay, 2017a).

1.1 General Procedure

In VBL, all clips are produced by a professional video capture tool (such as Camtasia Studio or equivalent) based on the following procedure (Ghilay, 2017a):

- Before starting the video capture process, a title page is prepared including information about the institution, the lesson, the instructor, etc.
- For ensuring highest sound recording, a good quality headset is used.
- The major topics are divided into sub-topics that are covered by short clips. The creation of menu topics, allow learners to skip to subjects they are interested in.
- Before video capture, the text which forms the basis of the lesson is prepared.
- After saving each clip to a file, it undergoes rigorous quality control during the editing stage. While required, corrections are made in several ways depending on the type of mistake: In a case of unnecessary segment, it is deleted. If the error occurs in the audio explanation, the soundtrack of that particular section can be deleted and a new explanation is recorded instead. Usually, there is no need to repeat the whole process of capturing a complete clip. Instead, segments are repaired or improved.
- After completing the editing process, the final clip is produced in a common format (mp4 or equivalent) and shared on the course website.

In addition to the general procedure mentioned above, producing different types of quantitative courses has specific characteristics as follows:

1.1.1 Computer Courses

- For each clip that covers a certain topic/sub-topic, the lecturer demonstrates on the computer and explains in detail all that is written in the relevant text. For all the exercises, a complete solution is presented and explained. The entire demo including the instructor's audio narration, is recorded.
- Each recording includes key principles of the specific subject/exercise. The clips show how students can actually perform specific actions on a computer, as if they were taking part in a computer lab.

1.1.2 Theoretical Quantitative Courses

The process of producing clips for quantitative theoretical courses (such as statistics, mathematics or similar), which include lots of mathematical expressions, is based on the following method (Ghilay, 2018):

- For each main topic, a text file is prepared and uploaded to the course website (in pdf format). All texts are produced via a combination of a word processor and a specific tool designed for writing mathematical expressions and formulas (MathType or equivalent). It is designed to function from within the word processing application enabling to write down mathematical expressions conveniently and accurately.
- The pdf texts are the basis for the face-to-face lectures as well as the video clips. The process of producing clips for such quantitative theoretical courses is as follows:

1) Each main topic is divided into small subtopics.

2) Each clip covers one subtopic.

3) Before the recording stage, pdf text pages are maximally zoomed in full-screen mode. Every page is completely captured and the lecturer's explanations are recorded using the cursor for pointing out all relevant expressions and formulas.

4) During the editing stage, each page can be partially hidden and later on, gradually exposed, in accordance with the recorded lecture progress. Exposure can be done horizontally, vertically, or both. It gives the viewer a similar feeling to what occurs when an instructor writes on a blackboard. Contrary to handwriting, the mathematical expressions in the video are very clear and easy to read. The capture process is simple and further changes are made later, during the editing phase.

Recent studies have examined the characteristics and benefits of VBL for computer courses (Ghilay & Ghilay, 2015; Ghilay, 2017a) and mathematics (Ghilay, 2018) in face-to-face learning in higher education. The purpose of this study is to revalidate and expand the VBL model and examine whether there is a significant difference in the contribution of video capture to the learning process in various types of quantitative courses and ways of learning. The types of courses examined are computer-based and theoretical whereas the kinds of learning are distance versus face-to-face. Revalidating the model in a long term study and knowing if there are significant differences, may affect the viability of expanding the use of VBL in different categories of courses and ways of learning.

1.2 Examining VBL in Quantitative Courses

Quantitative courses require a deep understanding of complex terms, abstract ideas, and complicated procedures, necessary for solving quantitative problems (Ghilay, 2018). A recorded video lecture produced by video capture technology can be either an asynchronous replacement or a supplement for live lectures. Therefore, such clips are supposed to be suitable for distance learning as well as for face-to-face learning. In both types of learning, recorded lessons can be viewed several times, entirely or partially, according to learners' preferences.

The present research, a three-year comprehensive study, examined and compared the characteristics and advantages of VBL in various types of quantitative courses in higher education, both in distance and face-to-face learning: a computer course (PSPP), statistics, and mathematics. Six groups of students who studied the following three courses were examined:

- Fundamentals of PSPP (statistical software equivalent to SPSS): third year students.
- Introduction to Statistics: first year students.
- Mathematics for Business Administration: first year students.

All three courses were covered (not exclusively) by video clips produced by video capture. All students participated, studied in the Department of Management and Economics at the NB School of Design and Education, Haifa, Israel. The three courses included the following topics/subtopics.

1.2.1 Fundamentals of PSPP

- *Introduction to PSPP:* basic statistical processing, table of frequencies.
- *Data Editor:* determining variable type and label, variables values and labels, missing values.
- *Foundations of Descriptive Statistics:* measurement scales, discrete variables, continuous variables, histogram.
- *Syntax:* Creation, updating and running of syntax commands.
- *Case Selection:* file split, case selection and creation of random sample.
- *Descriptive Statistics – Additional Tools:* Descriptives, Explore.
- *Means:* mean calculation, sort by independent variables.
- *Computerized Variables:* variable computing, functions in mathematical expressions, date computing, creation of discrete variables.
- *Sort Files and Data Control:* generate reports to find missing/incorrect variables.
- *Statistical Conclusion (1):* independent samples t-Test, paired samples t-Test, one sample t-Test.
- *Statistical Conclusion (2):* ANOVA (one way analysis of variance).
- *Statistical Conclusion (3):* Correlations, crosstabs, and chi square test.
- *Statistical Tools Analysis:* reliability (Cronbach's alpha including item analysis) and factor analysis.

The course included 179 HD video clips with a total viewing time of 15 hours and 26 minutes. The clips covered all the course material (all lectures and exercises).

1.2.2 Introduction to Statistics

- Introduction: What is statistics, basic concepts, stages

of quantitative research, population and sample, probability theory, subjective probability, physical probability, introduction to descriptive statistics, and statistical conclusion.

- *Measurement Scales:* Measurement, types of scales - nominal, ordinal, interval, and ratio.
- *Types of Transformations:* Identify preserving transformation, order preserving transformation, positive linear transformation, ratio preserving transformation, variables and constants, discrete and continuous variables.
- *Group Data in Tables:* Distribution of frequencies, grouping in a table, the limits of a class (imaginary and real), class width, midpoint, equal width classes, cumulative frequency distribution, relative frequency distribution.
- *Visualization of the Distribution of Frequencies:* Bar chart, histogram and polygon, histogram for cumulative frequency distribution, density, symmetric bell shaped graph, positive and negative asymmetric graph, uniform graph, U shaped graph, multimodal graph.
- *Rules of Summation:* Basic use of Sigma (Σ), Sigma of constant, Sigma of multiply variable in constant, Sigma of sum, double Sigma.
- *Measures of Central Tendency:* Mode, midrange, median, and mean.
- *Measures of Dispersion:* What is dispersion, percentage of errors, range, maximum deviation, interquartile range, mean absolute deviation, mean squared deviation, variance, and standard deviation.
- *Relative Position of Data:* Comparison of different observations - a gap between the mean of two distributions, the same mean distributions and different dispersion, different observations, relative values, standard scores.
- *Distribution of Standard Scores:* Display raw and standard grades in charts, saving the ratio of intervals, add axis to standard grades (z), transformation of raw grades into standard grades and histogram drawing, histogram of proportions, comparison of proportional distributions.
- *The Standard Normal Curve:* Description of the curve, the normal approximation of the distribution of proportions, finding of areas below a standard normal curve, the cumulative distribution function of a standard normal variable, area values in the standard normal curve, matching a standard score to a value that is not in the table, calculating the relative frequency of values lower than a given value.

The course included 13 HD video clips with a total duration of 3 hours and 41 minutes. The clips covered topics 1-5 (lectures only).

1.2.3 Mathematics for Business Administration

- *Functions:* definition, set of points, operations between functions, linear function, graphic description of a straight line, a quadratic function, increasing and decreasing functions, single-valued function, inverse function, image, compound function, even and odd functions.
- *Linear Inequalities:* attributes, systems of inequalities, union and the intersection of inequalities, inequalities including roots, and absolute values.
- *Quadratic inequalities:* attributes, the inequality that exists for every x, quadratic inequalities including roots/absolute values, inequalities with fractions, third and fourth-degree inequalities.
- *Exponents and Roots:* definition, exponents' rules and properties, zero/negative exponents, laws of roots, fractional (rational) exponents, exponential equations.
- *Logarithm:* definition, logarithmic identities, change of base, particular bases, logarithms from both sides of an equation, logarithmic equations.
- *Arithmetic Sequence:* definition, the n^{th} term, the sum of the members.
- *Geometric Sequence:* definition, the n^{th} term, the sum of the members, infinite geometric series, cyclic fractures.
- *Derivative:* limit, definition of a derivative,

geometrical meaning, derivatives of polynomial functions, derivative of constant times a function, derivative of a constant, derivative of sum/difference of two functions, product rule, quotient rule, derivative of a composite function, derivative of a logarithmic function, derivative of an exponential function, the tangent equation that passes through a point which is not on the graph of the function, increasing and decreasing of functions, maxima and minima.

- *Integral:* indefinite integral – integration, immediate integrals, calculation of constant of integration, definite integral – the integration interval and area between curves.

The course included 33 HD video clips with a total duration of 6 hours and 36 minutes. The clips covered topics 1-8 (lectures only).

All clips were produced by Camtasia Studio based on the VBL general procedure as well as the different specific characteristics mentioned above (section B: general procedure, computer courses, and theoretical quantitative courses).

2. Method

The study examined the students' attitudes to VBL in three quantitative courses, which are divided into two categories: computer courses and theoretical courses (six groups studied for three years). The same lecturer prepared all the clips and conducted the three courses.

2.1 The Research Questions

The research questions intended to measure the influence of VBL on the learning process of quantitative courses. The following research questions were worded:

- What are the characteristics of VBL relating to learning of quantitative courses?
- What are the advantages of VBL for improving the learning process in such courses?

2.2 Population and Samples

Population: The population addressed through the study included all learners studying quantitative courses in Israeli institutes of higher education.

Samples: Six samples that have been examined are presented in Table 1.

2.3 Tools

Respondents were asked to answer an online five-point Likert scale questionnaire (1-strongly disagree, 2-mostly disagree, 3-moderately agree, 4-mostly agree, 5-strongly agree) consisting of 24 items and an open ended question. The questionnaire examined students' attitudes toward the above research questions and it was anonymous.

2.4 Data Analysis

The following six factors were examined:

The quality of video clips in the examined courses.

2.4.1 Characteristics of Effective Clips

- The importance of pedagogical characteristics for effective clips.
- The importance of technical quality for effective clips.

2.4.2 Advantages of Video Clips

- The flexibility of video clips.
- The effectiveness of video clips for learning.
- The superiority of video clips compared to texts.
- The superiority of video clips compared to face-to-face learning.

Table 2 summarizes the seven factors, the items composing them and the reliability. For each factor, a

No.	Course	Year	Semester	Way of Learning	Sample Size	Rate of Response
1	Fundamentals of PSPP	2015-16	2	Face-to-face	14	100% (14/14)
2	Mathematics for Business Administration	2016-17	1	Face-to-face	41	100% (41/41)
3	Mathematics for Business Administration	2016-17	2	Face-to-face	17	100% (17/17)
4	Mathematics for Business Administration	2017-18	1	Face-to-face	27	93.1% (27/29)
5	Introduction to Statistics	2017-18	1	Face-to-face	27	100% (27/27)
6	Fundamentals of PSPP	2017-18	1	Distance	19	100% (19/19)
	Overall				145	

Table 1. The Study Samples

Factors	Questionnaire's Questions
The quality of video clips (Alpha=0.878)	Lecturer's explanations were clear.
	Lecturer's voice was clear.
	Lecturer's explanations were made at a moderate pace.
	The course curriculum was fully covered by video clips.
	Videos presented and illustrated well all topics I had to learn.
The importance of pedagogical characteristics for effective clips (Alpha=0.768)	Clips' effectiveness depends on a lecturer's ability to explain clearly.
	I prefer that each clip would be short and address not too many topics.
	Clips' effectiveness depends on a lecturer's ability to speak clearly.
	Clips' effectiveness depends on a lecturer's ability to talk at a moderate pace.
	Video clips should fully cover the whole curriculum.
The importance of Technical quality for effective clips	Good training videos should be of high technical quality.
The flexibility of video clips (Alpha=0.782)	It is very advantageous to watch video clips many times as I wish without limitation.
	It is very helpful to watch video clips on times I choose.
The effectiveness of video clips for learning (Alpha=0.839)	The video clips were helpful for my learning.
	The clips had a significant contribution to my ability to deal with the curriculum.
	The video clips allow me to follow any course topic thoroughly.
	Videos allow me to assimilate the material optimally.
	Videos are a good way to understand problems in the course.
The superiority of video clips compared to texts	The advantage of video clips is that they explain and illustrate central issues in the course in a clear and efficient way, better than a combination of text and screenshots.
The superiority of video clips compared to face-to-face learning (Alpha=0.909)	Video clips are better than face-to-face learning.
	I can learn well through video clips only, without going to class.
	Video clips are a complete substitute for class lessons.
	If attendance was not mandatory, I would prefer to watch the videos and not get to most of the lessons.
	I prefer a video clip over a face-to-face lecture.

Table 2. Factors and Reliability

mean score was calculated (including standard deviation). Paired Samples t-test was conducted as well for checking significant differences between pairs of factors ($\alpha <= 0.05$).

3. Results

Table 3 presents the mean scores of six samples. Table 4

Factor	Sample	N	Mean	S.D
The quality of video clips	PSPP- 2015-16	14	4.79	.33
	Math-1 - 2016-17	41	4.81	.43
	Math-2 - 2016-17	17	4.88	.22
	Math-1 - 2017-18	27	4.71	.40
	Statistics-1 - 2017-18	27	4.59	.70
	Pspp-1 - 2017-18	19	4.80	.28
	Total	145	4.75	.45
The importance of pedagogical characteristics for effective clips	PSPP- 2015-16	14	4.45	.46
	Math-1 - 2016-17	41	4.74	.36
	Math-2 - 2016-17	17	4.81	.32
	Math-1 - 2017-18	27	4.67	.47
	Statistics-1 - 2017-18	27	4.59	.54
	Pspp-1 - 2017-18	19	4.63	.46
	Total	145	4.66	.44
The importance of technical quality for effective clips	PSPP- 2015-16	14	4.57	.51
	Math-1 - 2016-17	41	4.61	.77
	Math-2 - 2016-17	17	4.82	.39
	Math-1 - 2017-18	27	4.85	.36
	Statistics-1 - 2017-18	27	4.74	.53
	PSPP-1 - 2017-18	19	4.84	.50
	Total	145	4.73	.57
The flexibility of video clips	PSPP- 2015-16	14	4.93	.18
	Math-1 - 2016-17	41	4.90	.30
	Math-2 - 2016-17	17	4.85	.29
	Math-1 - 2017-18	27	4.94	.16
	Statistics-1 - 2017-18	27	4.69	.56
	Pspp-1 - 2017-18	18	4.86	.41
	Total	144	4.86	.36
The effectiveness of video clips for learning	PSPP- 2015-16	14	4.79	.27
	Math-1 - 2016-17	41	4.82	.40
	Math-2 - 2016-17	17	4.82	.22
	Math-1 - 2017-18	27	4.78	.34
	Statistics-1 - 2017-18	27	4.62	.63
	PSPP-1 - 2017-18	19	4.73	.37
	Total	145	4.76	.41
The superiority of video clips compared to texts	PSPP- 2015-16	14	4.71	.47
	Math-1 - 2016-17	40	4.70	.46
	Math-2 - 2016-17	17	4.88	.33
	Math-1 - 2017-18	27	4.56	.51
	Statistics-1 - 2017-18	27	4.81	.48
	PSPP-1 - 2017-18	19	4.79	.42
	Total	144	4.73	.46
The superiority of video clips compared to face-to-face learning	PSPP- 2015-16	14	4.33	.68
	Math-1 - 2016-17	41	4.31	.49
	Math-2 - 2016-17	17	4.58	.56
	Math-1 - 2017-18	27	4.66	.57
	Statistics-1 - 2017-18	27	4.40	.82
	PSPP-1 - 2017-18	19	4.23	.67
	Total	145	4.41	.63

Table 3. Samples' Mean Scores

presents ANOVA results intended to find out if there are significant differences between the mean scores of all the samples, relating to the factors mentioned above.

The ANOVA results can be summarized as follows:

- The quality of video clips: $F(5,139)=1.276$, $p=.278$
- The importance of pedagogical characteristics for effective clips: $F(5,139)=1.509$, $p=.191$
- The importance of technical quality for effective clips: $F(5,139)=1.078$, $p=.375$

Factors		Sum of Squares	df	Mean Square	F	Sig.
The quality of video clips	Between Groups	1.281	5	.256	1.276	.278
	Within Groups	27.899	139	.201		
	Total	29.180	144			
The importance of pedagogical characteristics for effective clips	Between Groups	1.446	5	.289	1.509	.191
	Within Groups	26.647	139	.192		
	Total	28.094	144			
The importance of technical quality for effective clips	Between Groups	1.736	5	.347	1.078	.375
	Within Groups	44.774	139	.322		
	Total	46.510	144			
The flexibility of video clips	Between Groups	1.158	5	.232	1.873	.103
	Within Groups	17.064	138	.124		
	Total	18.222	143			
The effectiveness of video clips for learning	Between Groups	.808	5	.162	.945	.454
	Within Groups	23.755	139	.171		
	Total	24.563	144			
The superiority of video clips compared to texts	Between Groups	1.517	5	.303	1.448	.211
	Within Groups	28.920	138	.210		
	Total	30.438	143			
The superiority of video clips compared to face-to-face learning	Between Groups	3.279	5	.656	1.667	.147
	Within Groups	54.693	139	.393		
	Total	57.972	144			

Table 4. Analysis of Variance: Comparison of Factors

- The flexibility of video clips: $F(5,138)=1.873$, $p=.103$
- The effectiveness of video clips for learning: $F(5,139)=.945$, $p=.454$
- The superiority of video clips compared to texts: $F(5,138)=1.448$, $p=.211$
- The superiority of video clips compared to face-to-face learning: $F=(5,139)=1.667$, $p=.147$

The above findings indicate that no significant differences were found between the means of all the samples, for all factors (ANOVA, $\alpha \leq 0.05$). Thus, the mean factors for all these six samples together are shown in Table 5.

Factors are divided into three main categories: Courses' video quality, effective clips' characteristics, and clips' advantages.

The findings of Table 5 can be summarized as follows:

- The quality of all video clips was enormously high in all different samples, courses or ways of learning (face-to-face or distance) in three different academic years (4.75). The meaning of this finding is that respondents' rate the lecturer's recorded explanations as tremendously clear and suitable.
- Moreover, they claim that the comprehensive video package, fully covers the whole curriculum of the course and also shows all the necessary topics. This result may be a prerequisite for examining all the other factors that pertain to the research questions. The intention was to measure the importance of high-quality clips and their advantages. The rationale is that it may be a waste of time to examine low quality video clips characteristics or their

Factors' Categories	Factors	N	Mean	S.D
Courses' video quality	The quality of video clips	145	4.75	.45
Effective clips' characteristics (first research question)	The importance of pedagogical characteristics for effective clips	145	4.66	.44
	The importance of technical quality for effective clips	145	4.73	.57
Video clips' advantages (second research question)	The flexibility of video clips	144	4.86	.36
	The effectiveness of video clips for learning	145	4.76	.41
	The superiority of video clips compared to texts	144	4.73	.46
	The superiority of video clips compared to face-to-face learning	145	4.41	.63

Table 5. Mean Factors: Six Samples together

contribution to the learning process. Therefore, it was very important that all the answers to the research questions will be based on the learners' experience with high-quality clips.

- With regard to the first research question (the characteristics of effective clips), students value the pedagogical characteristics as very important for the effectiveness of the videos (4.66). This means that to produce effective clips, a lecturer has to explain clearly and at a moderate pace, the clips should be short and cover the entire curriculum.

As for technical characteristics, they are perceived to be of paramount importance as well (4.73). Based on paired samples t-Test, there was no significant difference between these two factors ($t_{(144)}$=-1.581, p=0.116).

This means that these two factors are very highly and equally rated.

- Regarding the second research question (video clips' advantages), respondents value their flexibility (4.86) and effectiveness of learning (4.76) as great. Moreover, video clips are perceived to be better than texts (4.73) and face-to-face learning (4.41). According to Paired Samples t-Test, there is significant difference among all these four factors, except the second (the effectiveness of video clips for learning– 4.76) and the third (the superiority of video clips compared to texts – 4.73). There is no significant difference between these two factors ($t_{(143)}$=.817, p=.415).

The effectiveness of the learning process in quantitative courses (4.76) is expressed in the fact that it is very useful for learning and dealing with studies thoroughly, as well as for optimally assimilating subjects. Moreover, these videos are perceived to be excellent compared to texts (4.73). Their main advantage is that they are very helpful for improving the student's understanding of quantitative course problems, better than any combination of text and screenshots. Video clips are also perceived to be superior over face-to-face learning (4.41) although this factor's score is significantly lower that all the other three.

The open-ended question strengthens the closed items and gives them more validity as presented in the following quotations of respondents.

3.1 Fundamentals of PSPP

"The benefits of combining videos is that I can learn at a time that suits me and can repeat the material several times until I understand very well. It is very important that the videos are very clear".

"It helps me a lot because I can go back and forth on the same video. It is easier and more convenient to concentrate at home at the right time for me".

"The videos of the lecturer are very clear and short and therefore they are considered interesting and I enjoy watching them very much. The speaker speaks in a clear, slow voice so that we can understand what he is saying. On the other hand, sometimes I have to ask a question or need an example but I cannot always disturb the lecturer. I like to combine both types of lessons, face-to-face and watching effective videos. Thanks".

3.2 Introduction to Statistics

"It was a great way to learn statistics".

"The videos are very clear so that the course becomes easier".

"A very good method. However, it does not completely replace the face-to-face lesson".

"This method is very effective and convenient".

3.3 Mathematics for Business Administration

"Videos are very effective, I can watch them conveniently, move them back and forth as I wish, the intonation is excellent and the demonstration is very good. For me, videos are a new phenomenon that helps me greatly in the learning process".

"The videos are perfect, thank you for the effort you're making to make it a success".

"The videos allow me to study all the material without being in class, I recommend that attendance will not be mandatory".

The above quotations reinforce the high effectiveness of VBL for learning quantitative courses in higher education. The clips are not necessarily a substitute for a live lecture, but may be an outstanding addition that helps students learn subjects they have not understood or missed. To be

effective, videos have to be focused on specific topics, they must be short, clear, and fully cover the whole course curriculum.

Conclusion

Studying quantitative courses in higher education is usually quite difficult because it is necessary to understand complex principles and procedures. Further knowledge of such courses is the ability to solve complex, theoretical, or computer-based problems. Creating a course that comprehensively supports the acquisition of such knowledge, is not simple. VBL (Video-Based Learning) model intends to offer a solution for this important problem which is common to all higher education institutions around the world.

The present three-year study examined VBL in various types of quantitative courses (computer-based and theoretical), various learning methods (distance and face-to-face), and different groups and times. The objective was to revalidate and expand the VBL model and to examine the differences (if any) in the contribution of the model to the learning process of several types of groups.

The findings show that there are no significant differences between all the groups examined. This means that regardless of the learning style or type of course, the results remain stable over time. VBL has four significant advantages for various types of quantitative courses in higher education: very high flexibility (4.86), significant contribution to the learning process (4.76), superiority of video clips over text reading (4.73), and face-to-face learning (4.41). This means that the VBL has great advantages both for traditional classroom learning as well as for online distance learning.

Recommendation

Due to VBL's main contribution to the process of learning quantitative courses, it is recommended to adopt this model in the relevant faculties of higher education. To do this in practice, it is necessary to create and deliver training programs so that the academic staff will be familiar with the principles of video capture, methods, and pedagogy. The research makes it clear that videos do not necessarily have to be a substitute for other methods of learning - they can often be complementary. The principles of screencasting, as well as additional skills required for online learning, can be purchased on the basis of the TMOC (Training for the Management of Online Courses) model (Ghilay, 2017a; Ghilay & Ghilay, 2014). It should be emphasized that the implementation of the VBL model is based primarily on the personal knowledge of faculty rather than investing in expensive equipment or development teams.

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