Peer-Reviewed Article

Quantitative Courses in Higher Education: Effectiveness of a Comprehensive Course Website

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Abstract: The aim of the study was to examine the effectiveness of a course website prepared by Moodle in higher education. The goal was to examine students' views towards comprehensive quantitative course websites. The research was based on three samples of students who studied three quantitative courses, accompanied by a Moodle website. All three course sites were meticulously prepared by a lecturer who is experienced in educational technology. Each site covers the course fully, including texts, links, video lectures, exercises, and exams. Students were asked to fill out an online questionnaire to assess the importance of different features of the course site, as well as to evaluate these features for the sites they studied with. Moreover, they were asked to evaluate the contribution of the course site to their learning.

The study findings show that according to students' perceptions, Moodle comprehensive course site was perceived as very important for learning quantitative courses. The specific sites examined were highly rated for the following characteristics: communication with the lecturer, course text, monitoring and evaluation, learning convenience, and videos. Moreover, it was found that the course site has a tremendous contribution to the process of learning quantitative courses. Due to the extensive contribution of comprehensive course sites to the study of quantitative courses, it is recommended to develop such sites properly in institutions of higher education, which teach courses of this type.

Keywords: learning management systems, Moodle, learning, educational technology

Introduction

General Background

A course site is a web-based tool designed for managing, documenting, monitoring, reporting, and delivering a course in both higher education and other educational systems,

whether they be in traditional classrooms, distance learning, or a hybrid of the two. A course website may include a variety of resources (texts, hyperlinks, audio, images, video clips, etc.) and can be helpful for establishing communication among students and instructors (discussion forums, messages, emails, instant messages, etc.). It is also useful in monitoring and evaluating student progress via assignment management applications, exams, exercises, and attendance registration. With this wide range of functions, a course website becomes a central tool for group study and an intersection for links to internal and external resources. One easy way for lecturers to develop a course site to meet the needs of students in higher education is by using a learning management system (LMS) (Ghilay, 2017).

LMSs have become widely used in higher education (Dobre, 2015). According to an Educause Center for Analysis and Research (ECAR) survey, 85% of faculty use an LMS (with 56% using it on a daily basis), and 83% of students use an LMS (with 56% using it in most or all courses) (Brown, Dehoney, & Millichap, 2015, p. 2). Higher education institutions benefit from using an LMS in many ways, including: (a) flexible access to learning content, (b) a centralized location for learning, (c) tracking and reporting tools to enhance student learning and performance, (d) increased efficiency in student activities, (e) increased communication, and (f) learning analytics.

Moodle (Modular Object-Oriented Dynamic Learning Environment) is one of the most common learning management systems in the academic world (Ghilay, 2017). It has a market share of 19.1% (713 institutions) and is ranked second in the world (Edutechnica, 2016). Moodle uses open source PHP code that was first developed by Martin Dougiamas while he was working at Curtin University. Moodle is currently managed by Moodle Pty Ltd, who regularly implement improvements and upgrades to the software. It can be installed free of charge on an institutional server or by purchasing storage services, installation, and maintenance from a company engaged in that activity (Ghilay, 2017).

Moodle and similar LMSs exhibit several characteristics designed to meet learner and faculty needs (Ghilay, 2017):

1. **Closed groups.** The system is primarily (though not always) designed for private groups of students who belong to an individual course or course group.
2. **Hierarchy of authorizations.** The system is based on a hierarchy of user roles (manager, course creator, teacher, non-editing teacher, student, guest, etc.) with

each user in the hierarchy having both permitted and prohibited actions. The principal distinction is between students and lecturers: lecturers can update course content whereas students may usually only watch, read, or submit assignments. Nevertheless, specific authorization for access to certain resources may be granted to users not usually having these permissions.

3. **Hidden and displayed items.** The system has options for concealing a single element, a group of articles, or a complete course from the eyes of learners. Furthermore, it is possible to protect individual items based on criteria (such as group membership or even more complex conditions).
4. **User registration and opening course sites.** A lecturer can manually manage user registration including appropriate permissions as well as create course websites manually (based upon proper authorization).
5. **Editing and duplicating.** Every item in the system can be updated, deleted, or duplicated. The possibility of duplicating items may assist faculty in preparing question banks for exams. In this way, workflow can be streamlined, eliminating the necessity to build every single element from scratch.
6. **Resource types.** The system can manage groups of central resources such as:
    a. ***Files.*** Different kinds of files (text, images, audio, or videos) and folders.
    b. ***Communication.*** Messages, emails, chats, and forums.
    c. ***Links.*** Different links can be defined for internal or external resources.
    d. ***Formatted pages.*** Advanced users can independently design pages including text, hyperlinks, images, embedded video and so on.
    e. ***Assignments.*** Different kinds of coursework can be defined and submitted through the system subject to various restrictions determined by the instructor (such as dates, the number of items submitted, file size, group membership, etc.). Complete communication between students and lecturer regarding an assignment can be managed including enablement of resubmissions.
    f. ***Exams/exercises.*** Different kinds of question banks can be created (multiple choice, matching, essay, and many others) and may be divided into subtopics as needed. Different restrictions can be determined for every practice/test such as the amount of permitted submissions, time limit, date limit, mixing of

questions and answers, random retrieval of issues from certain topics, reliance on previous submissions, restrictions regarding where exams can be taken, etc.

g. ***Reports.*** Monitoring of learner activity, which resources were accessed, when, for how long, from what IP address, students' personal details, etc.

h. ***Unique applications.*** The system enables the use of specific applications such as a glossary, blog management, Wiki, etc.

Dahlstrom, Brooks, and Bichsel, (2014) found the following characteristics of LMS users:

- Faculty and students value the LMS as an enhancement to their teaching and learning experiences, but relatively few use the advanced features.
- User satisfaction is highest for basic LMS features and lowest for advanced applications.
- According to stakeholders, faculty could be more effective instructors while students could learn better if both were more skilled using LMS.
- Mobile devices have become available to students everywhere, and mobile access to organizational systems designed for students like the LMS is becoming more and more common and important.
- Students and faculty want the LMS to have enhanced features and operational functions, be personalized, and use analytics to enhance learning outcomes.

Many studies look at the performance or the perceptions of students using an LMS. Research studies conducted in the 2000s indicate that students' satisfaction with an LMS is affected by course content and design (Selim, 2007), course quality and perceived ease of use (Sun, Tsai, Finger, Chen, & Yeh, 2008), and perceived usefulness and self-efficacy (Liaw, Huang, & Chen, 2007).

Altunoğlu (2017) found that students' interactions with an LMS were personally driven; though they achieved similar levels of success, different students used different approaches to the LMS, with variation "both found in students' prioritizing their preference of the type of e-learning material and in unit content" (p. 100). The students' most intense criticism of the course

sites focused on the quality of the content, such as exercises or chapter summaries, or on the content's variety.

Emelyanova and Voronina (2014) looked at a pilot LMS implemented at National Research University in Russia. Here the results were more negative: they found that students perceived that the convenience of the LMS was slightly above average, that the LMS was an ineffective tool for managing their learning process, and the grading made with the LMS was less objective.

A study by Mwalumbwe and Mtebe (2017) at Mbeya University of Science and Technology indicates that forums, peer interaction, and exercises are significant factors for students' academic achievement in blended learning. However, the time spent on LMS, the number of downloads, and the frequency of entry did not significantly affect students' learning performance

Additional recent studies examining learners' perspectives found that an LMS course site is helpful for the convenience of learning, it has a positive contribution to the learning process (Ghilay, 2017) and the course site is an effective tool to facilitate learning because of its interactive environment and availability (Kurata, Bano & Marcelo, 2018).

Ghilay (2017) provided evidence that the effectiveness of the course site depends to a large extent on the degree of investment by the lecturer. Students explicitly pointed out that they received significant support for their learning process only when the course site was well maintained. Indeed, the ability of faculty members to manage their course sites properly depends upon the knowledge and skills that they have acquired. Faculty point out unambiguously that they need guidance and direction and without them, they find it difficult to meet student expectations (Ghilay, 2017).

Ghilay (2019) also examined the effectiveness of course sites according to views of lecturers with different levels of activity in LMS. The findings indicated that there was a significant difference between two groups of lecturers: (a) faculty members whose level of activity in LMS is medium or higher and (b) lecturers whose level of activity is low. With regard to the first group, all of the course site characteristics examined were very highly rated. On the other hand, in relation to the second group, most of the factors examined were rated with lower than intermediate scores. As such, it was recommended that institutions of higher education influenced their faculty members to increase their activity in LMS. In cases where the

reason for low level of activity is lack of knowledge or skills, it can be helpful to direct the lecturers to appropriate training programs. If the reasons for the low activity are other, Ghilay (2019) recommends to identify them, and as a result, encourage and motivate faculty members both intrinsically and extrinsically so that they become more active in LMS.

Examining the Effectiveness of Quantitative Comprehensive Course Sites

Ghilay (2018) claims that learning quantitative courses in higher education can be difficult because "students need to understand complex principles and procedures and solve complicated questions" (p. 14) . These courses use a hierarchical structure, with new knowledge depending on previously accumulated knowledge. When students experience a gap in this prior knowledge, it becomes more difficult to overcome. Ghilay's (2018) Comprehensive Technology-Based Learning (CTBL) model was created to alleviate this knowledge gap burden. The CTBL model can be employed on a course site that provides full coverage of the curriculum by implementing an ongoing process of diagnosis and prognosis designed to overcome students' difficulties and knowledge gaps.

The present study examines students' attitudes regarding various characteristics of quantitative comprehensive course sites (here defined as a course site based on the CTBL model) constructed using the Moodle LMS. These attributes are divided into two main categories:

1. The importance of the characteristics.
2. The current situation of these characteristics.

These features were examined in various types of quantitative courses in higher education, both in face-to-face and distance learning: mathematics, statistics, and a computer course (PSPP). Three groups of students who studied the following courses were examined:

1. **Mathematics for Business Administration.** First-year students (face-to-face).
2. **Introduction to Statistics.** First-year students (face-to-face).
3. **Fundamentals of PSPP (statistical software equivalent to SPSS).** Third-year students (distance).

All three courses had a comprehensive Moodle site based on the CTBL model including the following components:

1. Access to all resources from one single page (designed by Moodle tab display).
2. A complete coverage of the course texts.
3. All lectures (video).

4. Solutions to all exercises (using texts for math/statistics and video clips for PSPP).
5. Computerized exercises (practice and submission).
6. Feedback questionnaires.
7. All the practice files and software tools (such as .sav files for PSPP, TeamViewer quick support for all courses, etc.).
8. Practice computerized exams.
9. Final computerized exams.
10. Students' attendance (relevant to face-to-face courses only: math and statistics).

All students who participated in the study were enrolled in courses in the Department of Management and Economics at the NB School of Design and Education, Haifa, Israel during the first semester of the 2017-2018 school year. The three courses included the following topics:

Mathematics for Business Administration. Functions, linear inequalities, quadratic inequalities, exponents and roots, logarithms, arithmetic sequence, geometric sequence, derivatives, and integrals.

Introduction to Statistics. Introduction - basic terms, measurement scales, group data in tables, visualization of the distribution of frequencies, rules of summation (basic use of Sigma and Sigma rules), measures of central tendency (mode, midrange, median and mean), measures of dispersion, relative position of data (standard scores), distribution of standard scores, and the standard normal curve.

Fundamentals of PSPP. Introduction to PSPP, data editor, foundations of descriptive statistics, syntax, case selection, additional tools for descriptive statistics, means, computerized variables, sort files and data control, independent samples t-test, paired samples t-test and one sample t-test, ANOVA (one way analysis of variance), correlations, crosstabs and chi-squared test, and reliability (Cronbach's alpha including item analysis) and factor analysis.

Methods

The study examined students' attitudes toward three quantitative course sites, which are divided into two categories: theoretical courses and computer courses. The same lecturer prepared all the course sites and conducted the three courses.

The Research Questions

The research questions intended to examine the characteristics and advantages of effective quantitative course sites in higher education. The following research questions were worded:

- "What are the characteristics of effective quantitative course sites according to students' attitudes?"
- "Based on the learners' views, what are the advantages of effective course sites in the process of learning quantitative courses?"

Population and Samples

Population. The research population addressed through the study included all those who were studying quantitative courses, accompanied by a course site at institutions of higher education in Israel.

Sample. Three samples that have been examined are presented in Table 1:

Table 1

The study samples

No.	Course	Year	Semester	Way of learning	Sample size	Rate of response
1	Mathematics for Business Administration	2017-18	1	Face-to-face	27	93.1% (27/29)
2	Introduction to Statistics	2017-18	1	Face-to-face	26	96.3% (26/27)
3	Fundamentals of PSPP	2017-18	1	Distance	17	89.5% (17/19)
	Overall				70	

Tools

Respondents were asked to answer an online five-point Likert scale questionnaire consisting of 62 items (see Table 2 for a detailed list) broken down as follows:

- 28 items intended to examine the preferred situation: importance of characteristics of effective course sites (1-very low importance, 2- low importance, 3-moderate importance, 4-high importance, 5- very high importance).
- The same 28 items were presented again to examine the current status: evaluating these characteristics regarding to the three course sites examined (1-very bad, 2-bad, 3- good, 4-very good, 5-excellent).
- 6 items intended to examine the contribution of a comprehensive course site to the learning process (1- very little, 2- little, 3-moderate, 4-much, 5-very much).

At the end of the questionnaire, the following open-ended question was added:

- "Does the course site help you in the learning process? Please explain and detail your answer."

Data Analysis

The following six factors divided into two main categories (inputs and their outcome) were examined:

Inputs.

- The convenience of the course site.
- Texts.
- Video clips.
- Monitoring and evaluation.
- Communication with the lecturer.

Outcome.

- The contribution of the site to the learning process.

Table 2 summarizes the six factors, the items composing them, and the reliability. Regarding the first five factors, two values of reliability are presented: relating to the importance of the characteristics (the first) and the current status (the second). For each factor, a mean score was calculated (including standard deviation). One Way ANOVA was conducted for checking significant differences among the above three courses. A paired samples t-test was undertaken as well for checking significant differences between pairs of factors ($\alpha \leq 0.05$).

Table 2

Factors and reliability

Factors	Questionnaire's Questions
Convenience of the course site (α = 0.905/0.913)	Nice shape.
	The menu is friendly and easy to use.
	Concentration of all learning resources in one place.
	Easy login from a variety of tools: PC, Mobile, Tablet, Smartphone.
	The possibility to study at any time, 24 hours a day, 7 days a week.
	Quick access to all learning needs.
	Easy operation of the site.
	Overcome time and place restrictions.
	Possibility to continue studying outside the classroom.
	Easy presentation of course topics.
Texts (α = 0.954/0.871)	Full coverage of the texts according to the course curriculum.
	Clear wording of the texts.
	Clear presentation of mathematical expressions in texts.
	Displaying the texts in the correct order.
	Presentation of solutions for all exercises (lectures, class exercises, and submission exercises).
	Comprehensive feedback questionnaires for each topic.
	Mathematical accuracy of all texts in the course.
Video clips (α = 0.916/0.965)	Full coverage of the entire curriculum using videos.
	A clear presentation of the mathematical expressions in the video clips.
	Clear explanations in video clips.
	Introducing the videos in the correct order.
	Short duration of each video.
	High technical quality of video clips (high resolution).
	Mathematical accuracy of all video clips in the course.

Monitoring and evaluation (α = 1.000/0.901)	Submission of exercises through the site. Submission of tests through the site.
Communication with the lecturer (α = 0.948/1.000)	Effective communication with the lecturer (messages, forums, etc.). The possibility of receiving online assistance from the lecturer.
Contribution to the learning process (α = 0.926)	The course site helps me in the process of learning a quantitative course. I prefer a quantitative course that is accompanied by a Moodle site and which covers the course well over courses where there is no site. The site improves the learning process as it is regularly updated according to the learning needs of the course. A combination of different resources in the course site (text, video, exercises, etc.) helps me learn a quantitative course. The Moodle site helps me understand the material in the course. I would prefer that all the quantitative courses in the college would have a Moodle site that fully covers the curriculum.

Results

Table 3 presents the mean scores of the three samples.

Table 3

Samples' mean scores

Factor	Course	Importance			Current Status		
		N	Mean	S.D.	N	Mean	S.D.
Convenience	Math	27	4.60	.50	27	4.74	.39
	Statistics	26	4.69	.49	26	4.79	.37
	PSPP	17	4.52	.37	17	4.52	.31
Texts	Math	27	4.76	.40	27	4.74	.42
	Statistics	26	4.77	.38	26	4.75	.40
	PSPP	17	4.48	.61	17	4.67	.44
Video clips	Math	27	4.68	.38	27	4.62	.51
	Statistics	26	4.68	.38	26	4.57	.59
	PSPP	17	4.63	.46	17	4.51	.58
Monitoring and evaluation	Math	27	4.78	.42	27	4.74	.45
	Statistics	26	4.85	.37	26	4.77	.43
	PSPP	17	4.65	.70	17	4.62	.42
Communication with the lecturer	Math	27	4.85	.36	27	4.78	.42
	Statistics	26	4.92	.27	26	4.77	.43
	PSPP	17	4.82	.50	17	4.76	.44

Factor	Course	N	Mean	S.D.
Contribution to the learning process	Math	27	4.62	.49
	Statistics	26	4.63	.49
	PSPP	17	4.55	.44

Below are One Way ANOVA ($\alpha \leq 0.05$) results intended to find out if there are significant differences between the mean scores of all the samples, relating to the factors mentioned above:

Importance of Characteristics

- **Convenience:** $F_{(2,67)} = 0.689$, p = .506
- **Texts:** $F_{(2,67)} = 2.502$, p = .090
- **Video clips:** $F_{(2,67)} = 0.085$, p = .918
- **Monitoring and evaluation:** $F_{(2,67)} = 0.860$, p = .428
- **Communication with the lecturer:** $F_{(2,67)} = 0.431$, p = .652

Current Status

- **Convenience:** $F_{(2,67)} = 3.031$, p = .055
- **Texts:** $F_{(2,67)} = 0.224$, p = .800
- **Video clips:** $F_{(2,67)} = 0.211$, p = .810
- **Monitoring and evaluation:** $F_{(2,67)} = 0.673$, p = .513
- **Communication with the lecturer:** $F_{(2,67)} = 0.005$, p = .995

Outcome

- **The contribution of the site to the learning process:** $F_{(2,67)} = 0.173$, $p = .842$

The above findings indicate that no significant differences were found between the means of all the samples, for all factors. The mean factors for all these samples together are shown in Table 4 below.

Table 4

Mean factors: Three samples together

Factor	Importance			Current Status		
	N	Mean	S.D.	N	Mean	S.D.
Communication with the lecturer	70	4.87	0.37	70	4.77	0.42
Texts	70	4.69	0.47	70	4.73	0.41
Monitoring and evaluation	70	4.77	0.49	70	4.72	0.43
Convenience	70	4.61	0.47	70	4.70	0.38
Video clips	70	4.67	0.40	70	4.58	0.55

Factor	N	Mean	S.D.
Contribution to the learning process	70	4.61	0.47

The findings of Table 4 can be summarized as follows:

Regarding the current status, all factors have been very highly rated by learners for all the different courses or ways of learning: communication with the lecturer (4.77), texts (4.73), monitoring and evaluation (4.72), convenience (4.70) and video clips (4.58). To find out whether there are significant differences between the five factors mentioned above (for both importance and current status), a paired samples t-test was undertaken. Based on this statistical test, there were no significant differences between the first four factors. This means that the first four factors are very highly and equally rated. Regarding the fifth factor (video clips), there was a significant difference between it and all the others. Although these differences are significant, the gaps are very small: the lowest mean (current status, video clips: 4.58) is only 4% lower than the highest (communication with the lecturer: 4.77). Therefore, it can be concluded that all 5 factors are highly rated, as all factor values are 4.58 or higher.

Besides, the importance of all these factors is also perceived to be very high (all mean values are higher than 4.6): communication with the lecturer (4.87), texts (4.69), monitoring and evaluation (4.77), convenience (4.61) and video clips (4.68). In addition, the course site was found to provide a significant contribution to the learning process (4.61).

This means that students evaluate the comprehensive course site as providing excellent communication with them, the texts and assessment process are very useful, the site is very convenient to use, and the video clips are very useful for their learning. Moreover, all these characteristics are perceived as very important for students' learning. For the bottom line, comprehensive course sites are perceived to have a great impact on students' learning, as they have a direct and very high contribution to their learning.

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

Mathematics for Business Administration:

- "The course site helps me learn and understand all the topics independently and at my own pace."
- "The course Mathematics for Business Administration is the best in college and I understand everything even though the material is not easy."

Introduction to Statistics:

- "The course is very interesting. It is very good that there is an opportunity to learn through the course website - the material is interesting and the method of study creates motivation."
- "Thanks to the course site, everything was clear and understandable."

Fundamentals of PSPP:

- "The course site helps me a lot in the learning process."
- "The course website is very helpful for me to learn."

The above quotes emphasize the high effectiveness of the comprehensive site for the study of quantitative courses in higher education. Since quantitative courses are difficult to understand, a comprehensive site is perceived as very helpful for students' learning and assimilation of course topics.

Discussion

Studying quantitative courses in higher education is difficult because students should understand complex principles and procedures. In such courses, learners must acquire the ability to solve theoretical complex problems (such as using mathematics or statistics), or computer-based problems (such as using PSPP). Creating a course site that comprehensively supports the acquisition of such knowledge is not straightforward. It should systematically cover the whole course curriculum via different learning means, such as texts or video clips. In quantitative courses, comprehensive coverage means that the site includes all the lectures and solutions of exercises designed for both practice and submission and enables effective contact with the lecturer for the continuous support of the learners when they encounter difficulties.

The present study examined comprehensive sites of various types of quantitative courses (theoretical and computer based) and different learning methods (face to face and distance). The findings show that there are no significant differences between all the samples examined. This means that regardless of the learning style or type of quantitative course, the results remain stable, provided that the course site is indeed comprehensive. Such a site has five major advantages: the students receive excellent communication with the lecturer, the texts and the evaluation process are very helpful, the site is very convenient to use, and the videos help students understand and assimilate the content, even on very difficult issues. The result of these

important elements in a quantitative course website is that such a site significantly affects students' learning.

Due to the extensive contribution of comprehensive course sites to the study of quantitative courses, it is recommended to develop such sites properly in institutions of higher education that teach courses of this type. Unfortunately, not all faculty members are familiar with various topics of educational technology, especially the management of online courses. In order to do this in practice, it is necessary to create and deliver training programs, so the lecturers will be familiar with the principles and practice of creating and managing comprehensive course sites. As institutions of higher education face the challenge of training faculty to become qualified comprehensive course managers, the TMOC (Training for Management of Online Courses) model can provide an answer to this challenge (Ghilay, 2017; Ghilay & Ghilay, 2014). TMOC model has two fundamental components:

1. **Curriculum.** The specific topics lecturers should be familiar with in order to manage online courses.
2. **Learning methodologies.** Exemplification of the diverse ways in which lecturers can design their own online curriculums to meet various student needs and learning styles.

It should be emphasized that the realization of this goal is mainly based on the knowledge that the lecturers need to acquire, based on existing resources.

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