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COMPREHENSIVE TECHNOLOGY-BASED LEARNING (CTBL): A COMPARISON BETWEEN VARIOUS TYPES OF QUANTITATIVE COURSES

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Abstract. Learning quantitative courses in higher education is difficult because students need to understand complex principles and solve complicated questions. In these courses, new knowledge depends on prior knowledge and when gaps in students' understanding occur, they are difficult to overcome. The study examines a new model called comprehensive technology-based learning (CTBL) designed to overcome these difficulties.
The problem is addressed by full coverage of the curriculum in a variety of textual and video learning tools, as well as an ongoing process of diagnosis and prognosis, designed to overcome students' difficulties and knowledge gaps. The study examined the students' attitudes towards CTBL model relating to three quantitative courses $(n_1 = 39,\ n_2 = 25,\ n_3 = 18,\ n_{total} = 82)$. It points out that a quantitative course based on CTBL significantly nurtures students' learning. Improving learning and overcoming knowledge gaps are influenced by several characteristics: Full coverage of the curriculum, excellent learning experience, repetition of the material without limitations, flexibility to learn outside the classroom, a variety of means to choose which ones are more appropriate, and making learning much easier. Beyond that, the diagnosis and prognosis done by the lecturer cause the instructor to intervene in real time, to solve the students' difficulties on an ongoing basis.

Keywords: CTBL: Comprehensive Technology-Based Learning; online learning; educational technology; quantitative course; feedback.

JEL Classification: I21; I23.

Introduction

Learning quantitative courses in higher education is difficult because students need to understand complex principles and procedures and solve complicated questions. Besides, these courses are based on a hierarchical structure, that is, new knowledge depends on prior knowledge. Therefore, when gaps in students' understanding 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. The Comprehensive Technology-Based Learning (CTBL) model intends to overcome these difficulties. This is achieved through the full coverage of the curriculum on the course site, the presentation of a variety of textual and video-based learning tools, and an ongoing process of diagnosis and prognosis designed to overcome students' difficulties and knowledge gaps. The first study, which examined the CTBL model, referred to computer courses only and found that it was very suitable for this type of courses (Ghilay 2017a). The present two-year study examined the model more thoroughly, and also referred to a different type of quantitative theoretical courses, such as mathematics or statistics. The degree of suitability for both courses (mathematics/statistics and computer courses) was examined, and also a comparison between them was made.

Description of the CTBL model

To ensure that the learning process in various types of quantitative courses is effective, a new paradigm has been adopted to provide a comprehensive and complete response to all student difficulties. The Comprehensive Technology-Based Learning (CTBL) model intends to offer a better educational environment than traditional learning. This includes the following major components (Ghilay 2017a):

1. *Full coverage of all learning needs including a variety of learning tools*: The course site includes full coverage of texts and video clips for all lectures. All videos are created through video capture technology. In addition, complete solutions are provided for all the exercises in the course as follows: For computer courses, all the solutions are presented through video clips, while for theoretical courses such as mathematics or statistics, they are provided using detailed text. When a student repeats the material taught in class or completes a missing element due to absence, it is possible to review all the material including exercises and solutions.
2. *Ongoing daily diagnostic process to find students' learning difficulties*: To address the problem of growing gaps and promoting students, lecturers are required to conduct an ongoing diagnosis of the learners' situation in order to identify the weak points and intervene in real time. Based on various digital communication channels, diagnosis is carried out in the following ways:
   - Feedback questionnaires covering each subtopic: At the end of every main topic, each student answers an online questionnaire covering all subtopics of the main topic.
   - Daily monitoring of exercises' status: All the course exercises and exams are computerized and the instructor can supervise the students' progress.
   - Constant monitoring of student attendance (for face-to-face courses) or entries to the course website (for distance courses): Through the course website, the lecturer can monitor the students' lack of class or level of activity on the site.
   - Questions and requests forwarded to the lecturer by the students: Questions or requests from students are transmitted through technology-based communication channels. This information is another important component of the diagnostic process used as the basis for the prognosis.
3. *Prolonged prognosis in order to solve students' learning difficulties*: This includes real-time intervention by the lecturer to provide an ongoing response to all students' difficulties. It is possible to solve problems by explaining unclear issues, adjusting the pace of progress, delaying the submission time or adding answering attempts while treating each student in an appropriate and individual manner. Help of any kind may be provided remotely through the various technology-based communication channels. In special cases, assistance can also be provided by connecting the lecturer to the student's computer and providing personal guidance. If students are missing or inactive, the lecturer can contact them and see if they need help.

Examining students' views towards the CTBL model

The present two-year study examined the students' attitudes regarding various characteristics of the CTBL model.

The intention was to examine different types of quantitative courses: theoretical, such as mathematics or statistics and computer courses and to check whether CTBL is effective for such difficult courses. Therefore, the following three courses, representing the majority of the quantitative courses, were selected: mathematics, statistics and a computer course (PSPP). Moreover, these characteristics were also examined in different ways of learning: face-to-face learning and distance learning.

The following research questions were designed to examine the characteristics and benefits of the CTBL model for quantitative courses in higher education:

- Does the CTBL model help improve the learning process of quantitative courses in higher education?
- If there is an improvement, what are the reasons?

Three groups of students who studied the following courses were examined:

1. Mathematics for business administration: first year students.
2. Introduction to statistics: first year students.

3. Fundamentals of PSPP (statistical software equivalent to SPSS): third year students.

The three courses examined were based on the CTBL model. Thus, at the beginning of each course, students were told they would learn in a specific way called comprehensive technology-based learning, including the following characteristics presented on the course website and on the board (in face-to-face lessons only):

1. Full coverage of the material in texts including answers to exercises.

2. Full video coverage of the material.

3. Feedback questionnaires at the end of each topic.

4. Complete coverage of the course files.

5. Guided practice in class.

6. Asking questions and receiving answers during and outside the lesson (including connecting to the student's computer at home).

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:

Mathematics for business administration: Functions, linear inequalities, quadratic inequalities, exponents and roots, logarithms, arithmetic sequence, geometric sequence, derivative, integral. *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, the standard normal curve.

Fundamentals of PSPP: Introduction to PSPP, data editor, foundations of descriptive statistics, syntax, case selection, descriptive statistics – additional tools (Descriptives and Explore), 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 square test, reliability (Cronbach's alpha including item analysis) and factor analysis.

Literature Review

Texts in the digital age

Texts are essential in managing and supporting online learning. Before the digital age, texts were printed on paper and physically distributed to readers. In the digital age text is distributed over the Internet. Students now have access to enormous amounts of high-quality text without a limit on quantity. While learners can still print out the text on paper, these writings can now be comfortably read without printing them due to sophisticated mobile devices such as tablets and smartphones (Ghilay 2017a).

The most common digital replacement for paper output is the PDF (Portable Document Format) file invented by Adobe. It is able to accurately display digital documents regardless of platform (computer hardware or operating system). Today PDF is the accepted standard for distributing text files. A significant advantage of PDF is the ability to lock documents so they cannot be changed and thus prevent distortion. In the online learning world, it allows for the distribution of texts (and hypertext) produced by a variety of software tools without the necessity of acquiring the software that created the original document. Moreover, the PDF output is identical to that of the source so it can be read and printed (Ghilay 2017a).

Another advantage of PDF is the possibility of creating a single file that combines text from different sources, which can be numbered and arranged in any order enabling lecturers to prepare digital booklets that include texts from a variety of sources, such as a word processor, a spreadsheet, or a scanner (Ghilay 2017a).

Video in online learning

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; Ghilay 2017a; Ghilay 2017b). 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; Ghilay 2017a; Ghilay 2017b). Video capture is an exceptional substitute for video camera recording and it can give learners even more dynamic and exciting content (Ruffini 2012). Furthermore, since the clips can be stopped or reviewed anytime, anywhere (Screencast 2018), 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.

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 et al. 2010).

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

Feedback-based learning and real-time intervention

To address the problem of growing gaps and promoting students, lecturers are required to conduct an ongoing diagnosis of the learners' situation in order to identify the weak points and intervene in real time. In order to achieve an effective diagnosis, appropriate feedback is needed. Promoting student success in learning has become an issue of concern among educators all over the world (Elton, Johnston 2002; Knight, Yorke 2003; Race 2005). A substantial number 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 they 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 may be the missing component in successful outcomes (Felder, Brent 2004). Higher education will not be significantly improved, as Burksaitiene (2011) argues, until the feedback system is changed.

Feedback can have different functions depending upon the learning environment, the needs of the learner, the purpose of the task, and the feedback paradigm adopted (Poulos, Mahony 2008). 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).

Yet international research indicates that students respond very well to feedback delivered in a digital format. A meta-analysis of more than 7,000 studies (Hattie, Timperley 2007) reveals that multimedia feedback is one of the most effective ways to obtain positive results from feedback. While the term "feedback" refers to information provided to students to encourage them to improve their learning, information from students to lecturers may be just as transformative, assisting academic staff in changing their manner of teaching to better fit learners' needs. Often students are the first appraisers of whether teaching is good or not. That said, too many institutions are not geared to accept student insights in an atmosphere that genuinely welcomes such feedback. Although requesting student feedback on their learning experience at the end of a semester has become common practice in many institutes, their views may not have any actual impact. Institutions of higher education need to create environments and mechanisms that allow student views, learning experiences, and performance to be taken into account (McAleese et al. 2013).

A model called feedback-based learning (Ghilay 2017a; Ghilay, Ghilay 2015) 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. The model significantly improves student feedback to faculty by informing 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 issues that are surrounded by lack of clarity.

Methodology

The study examined the students' attitudes towards CTBL model relating to three quantitative courses, 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 following research questions were focused upon:

- Does the CTBL model help improve the learning process of quantitative courses in higher education?
- If there is an improvement, what are the reasons?

The research population addressed through the study included all those who were studying quantitative courses based on CTBL at institutions of higher education in Israel. Three samples that have been examined are presented in the Table 1.

Table 1. The study samples (Source: Author's compilation)

No.	Course	Year	Way of Learning	Sample Size	Rate of Response
1	Mathematics for business administration	2016-2017	Face-to-face	39	95.1% (39/41)
2	Introduction to statistics	2017-2018	Face-to-face	25	96.3% (26/27)
3	Fundamentals of PSPP	2017-2018	Distance	18	89.5% (17/19)
	Total			82	

Respondents were asked to answer an online 5-point Likert scale questionnaire consisting of 53 items (1 – strongly disagree, 2 – mostly disagree, 3 – moderately agree, 4 – mostly agree, 5 – strongly agree). At the end of the questionnaire, the following open ended question was added:

Does CTBL help you in the learning process? Please explain and detail the reasons.

The following nine factors divided into two main categories were examined (general evaluation of CTBL model and characteristics that may be reasons for its success/failure):

General evaluation of CTBL: CTBL contribution to learning quantitative courses.

Characteristics of CTBL: Full coverage, learning experience, repetition of the material without limitations, flexibility, variety of means, ease of learning, diagnosis and prognosis: The lecturer's intervention in real time.

Table 2 summarizes the nine factors, the items composing them and the reliability. For each factor, a mean score was calculated (including standard deviation). One-way ANOVA was conducted for checking significant differences among the three courses in the study. Paired samples t-test was undertaken as well for checking significant differences between pairs of factors $(\alpha \le 0.05)$.

Table 2. Factors and reliability (Source: Author's compilation)

Factors	Questionnaire's Questions
Contribution to learning quantitative courses (Alpha=0.868)	Comprehensive learning is helpful for better understanding of the material. Comprehensive learning helps me to be well prepared for the final exam. Comprehensive learning allows me to deepen my understanding of the material. Comprehensive learning produces meaningful learning. Comprehensive learning is better than traditional learning. I prefer comprehensive learning over regular modes of learning.
Full coverage (Alpha=0.925)	Full textual coverage of the material helps me learn. Full video coverage of the material helps me learn. Full video coverage of all exercises is helpful. The clips on all the theoretical material are helpful for my progress. The clips on all the exercises are useful for my progress.
Learning experience (Alpha=0.946)	Comprehensive learning allows me to be active. The learning experience is much better. I enjoy learning with technology. Comprehensive learning makes learning much more attractive. Comprehensive learning increases my motivation. I have the feeling that the lecturer is interested in me. I have the impression that the lecturer is interested in my progress. It is convenient for me to turn the lecturer even outside of class. The lecturer invites us to keep in touch with regard to our studies Comprehensive learning improves my ability to concentrate.
Repetition of the material without limitations (Alpha=0.839)	It is easy to understand issues that are unclear by watching video clips again It is easy to understand unclear issues by reviewing comprehensive texts again. It is possible to get better by repeating recorded lectures and exercises.
Flexibility (Alpha=0.952)	The combination of technology and connection to the lecturer has added value. There is a complementary relationship between technological tools and human involvement. The limitation of meeting time and location is significantly reduced. It is easy to continue learning outside of class.
Variety of means (Alpha=0.957)	The variety of learning alternatives allows me to overcome difficulties. The variety of alternatives allows the lecturer to focus on important issues. The variety of alternatives allows learners to select the most appropriate tools. Ways of learning can be suited to personal learning styles. Students are exposed to a huge variety of exercises to solve. The variety of learning alternatives improves my ability to handle difficulties. Practicing various alternatives improves learning. The variety of practice exams is excellent preparation for the final exam. Getting an answer using various channels of communication is helpful.
Ease of learning (Alpha=0.854)	Comprehensive learning helps overcome difficulties more easily. It is very easy to demonstrate complex issues. Overcoming gaps is easy.
Diagnosis (Alpha=0.864)	Concurrent online feedback is helpful in diagnosing difficulties in real-time Concurrent online feedback is useful in eliminating knowledge gaps in real-time. Current monitoring of the status of the exercises is helpful. Constant monitoring of student activity is useful.
Prognosis: The lecturer's intervention in real time (Alpha=0.923)	The prompt response of the lecturer to our requests contributes greatly to learning. The lecturer shares helpful techniques for learning. Having academic assistance in class is helpful. Having academic assistance at home is helpful. Having assistance with installation and use of software tools is useful. It is easy to understand unclear issues by having additional help from the lecturer in real-time. The lecturer's willingness to help is crucial for eliminating gaps. Only few gaps are created since difficulties are dealt with immediately It is easy to have either human or technological feedback in real-time.

Results

Table 3 presents the mean scores of the three samples:

Table 3. Samples' mean scores (Source: Author's compilation)

Factor	Course	N	Mean	S.D	Factor	Course	N	Mean	S.D
Contribution to learning	Math	39	4.54	.51	Variety of means	Math	39	4.56	.52
	Statistics	25	4.63	.41		Statistics	25	4.64	.50
	PSPP	18	4.60	.44		PSPP	18	4.57	.59
Full coverage	Math	39	4.57	.49	Ease of learning	Math	39	4.47	.56
	Statistics	25	4.68	.48		Statistics	25	4.61	.48
	PSPP	18	4.61	.54		PSPP	18	4.52	.55
Learning experience	Math	39	4.64	.47	Diagnosis	Math	39	4.44	.60
	Statistics	25	4.65	.49		Statistics	25	4.56	.55
	PSPP	18	4.49	.61		PSPP	18	4.56	.48
Repeat the material without limitations	Math	39	4.53	.52	Prognosis: The lecturer's	Math	39	4.58	.48
	Statistics	25	4.65	.45		Statistics	25	4.63	.45
	PSPP	18	4.61	.40		PSPP	18	4.59	.50
Flexibility	Math	39	4.50	.50					
	Statistics	25	4.64	.46					
	PSPP	18	4.63	.45					

Table 4 presents results of One Way ANOVA ($\alpha \leq 0.05$) intended to find out if there are significant differences between the mean scores of all the samples, relating to the factors mentioned above:

Table 4. One Way ANOVA results (Source: Author's compilation)

Category	Factor	ANOVA
General evaluation of CTBL	Contribution to learning	$F(2,79) = .305,\ p = .738$
Characteristics of CTBL	Full coverage	$F(2,79) = .345,\ p = .709$
	Learning experience	$F(2,79) = .690,\ p = .504$
	Repetition of the material without limitations	$F(2,79) = .553,\ p = .577$
	Flexibility	$F(2,79) = .783,\ p = .461$
	Variety of means	$F(2,79) = .200,\ p = .819$
	Ease of learning	$F(2,79) = .469,\ p = .627$
	Diagnosis	$F(2,79) = .489,\ p = .615$
	Prognosis	$F(2,79) = .113,\ p = .894$

The above findings indicate that no significant differences were found between the means of all the samples, for all factors. Therefore, the mean factors for all these samples together are shown in Table 5.

Table 5. Mean factors: three samples together (Source: Author's compilation)

Category	Factor	N	Mean	S.D
General evaluation of CTBL	Contribution to learning	82	4.58	.46
Characteristics of CTBL	Full coverage	82	4.61	.49
	Learning experience	82	4.61	.51
	Prognosis: The lecturer's intervention in real time	82	4.60	.47
	Repetition of the material without limitations	82	4.59	.47
	Variety of means	82	4.59	.52
	Flexibility	82	4.57	.47
	Ease of learning	82	4.52	.53
	Diagnosis	82	4.50	.56

As for the overall assessment of the CTBL model, the contribution to learning has been highly rated among learners (4.58). Students argue that CTBL is very helpful in understanding the material better and preparing for the exam and that it is much better than traditional ways of learning. Besides, all CTBL characteristics are perceived to be highly rated as well: Full coverage of the curriculum (4.61), learning experience (4.61), prognosis: The lecturer's intervention in real time (4.60), repetition of the material without limitations (4.59), variety of means (4.59), flexibility (4.57), ease of learning (4.52) and diagnosis (4.50).

Based on paired samples *t*-test $(\alpha \leq 0.05)$, there were no significant differences between the first four factors of the second category and the sixth: Full coverage (4.61), learning experience (4.61), prognosis (4.60), repetition of the material without limitations (4.59) and flexibility (4.57).

There were significant differences between the following pairs, presented in Table 6:

Table 6. Paired Samples T-test (Source: Author's compilation)

Pairs	T-test
Full coverage (4.61) – variety of means (4.59)	$t_{(81)} = 2.033,\ p = .046$
Full coverage (4.61) – ease of learning (4.52)	$t_{(81)} = 3.079,\ p = .003$
Full coverage (4.61) – diagnosis (4.50)	$t_{(81)} = 3.103,\ p = .003$
Learning experience (4.61) – ease of learning (4.52)	$t_{(81)} = 3.633,\ p = .000$
Learning experience (4.61) – diagnosis (4.50)	$t_{(81)} = 2.833,\ p = .006$
Prognosis: The lecturer's intervention in real time (4.60) – Ease of learning (4.52)	$t_{(81)} = 2.651,\ p = .010$
Prognosis: The lecturer's intervention in real time (4.60) – diagnosis (4.50)	$t_{(81)} = 3.008,\ p = .004$
Repetition of the material without limitations (4.59) – ease of learning (4.52)	$t_{(81)} = 2.216,\ p = .029$
Repetition of the material without limitations (4.59) – diagnosis (4.50)	$t_{(81)} = 3.255,\ p = .002$
Variety of means (4.59) – diagnosis (4.50)	$t_{(81)} = 2.160,\ p = .034$
Flexibility (4.57) – diagnosis (4.50)	$t_{(81)} = 3.854,\ p = .000$

This means that students evaluate the CTBL model as a great contribution to their learning while providing all learning needs, giving an excellent learning experience, great flexibility and a lot of learning tools. The diagnostic process is very effective in mapping the students' difficulties and is the basis for the effective intervention of the lecturer in real time when such intervention is required.

For the bottom line, CTBL has a significant impact on students facing the challenge of learning quantitative courses, as it makes a significant 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 method is very effective and very helpful for learning. I'm very pleased*". "*Learning with the new method is much more interesting and easier to focus on.*"

Introduction to statistics:

"*It is very good that we had an opportunity to learn using CTBL. I was very interested in all subjects and highly motivated.*"

Fundamentals of PSPP:

"*CTBL is very helpful for my learning process.*"

"*This is an extraordinary way of learning. It saves time and is very helpful*."

These statements are testimony to the high effectiveness of the CTBL model for the study of quantitative courses in higher education. Since quantitative courses are difficult to understand, CTBL is perceived as very helpful for students' learning and for making significant progress.

Conclusions

Studying quantitative courses in higher education is difficult, because students should understand complex principles and procedures. In such courses, learners have to acquire the ability to solve complex, theoretical problems like mathematics or statistics, or computer-based, such as PSPP. Running a course based on CTBL intends to support the acquisition of such knowledge.

The present two-year study examined the CTBL model for 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 among all the courses examined. This means that regardless of the learning style, the time or specific type of course, the results remain stable.

The study points out that a quantitative course based on CTBL significantly nurtures students' learning. This is achieved by creating a better learning environment, characterized by the following features, which are highly rated by learners.

1. *Full coverage of the course curriculum*: There is a double coverage of all lectures – full textual coverage as well as full video coverage. The duplication is not superfluous but creates a complementary connection between the two methods. Moreover, this can help students who prefer a particular learning style, choose what is more appropriate, or combine the two.
2. *Learning experience*: There is a unique learning experience that enables students to be active and enjoy learning while increasing their motivation. In addition, the students are more satisfied because they feel that the lecturer is interested in them and in their progress. So they are more likely to turn to the lecturer and ask for his/her help if necessary.
3. *Repetition of the material without limitations*: Students can easily understand unclear topics by re-watching videos or reading comprehensive texts again.
4. *Flexibility*: The combination of technology and connection to the lecturer has added value and the time and place constraints in face-to-face meetings are significantly reduced.
5. *Variety of means*: The variety of learning alternatives enables students to overcome difficulties, choose the most appropriate tools and suit them to personal learning styles. Students are exposed to a variety of exercises to be solved and practice exams, which is very helpful.
6. *Ease of learning*: CTBL helps to overcome difficulties more easily, making it easier to demonstrate difficult problems and overcoming gaps.

7. *Diagnosis*: The diagnostic process is based on an integration of online feedback questionnaires, daily monitoring of exercises' status, constant monitoring of student activity (attendance or activity on the course site) and requests forwarded to the lecturer by the students. All of these channels provide an excellent basis for the lecturer's focused interventions.
8. *Prognosis: The lecturer's intervention in real time*: This includes real-time intervention by the lecturer to provide an ongoing response to all students' difficulties, as found in the diagnostic stage.

Due to the significant contribution of the CTBL model to the learning of quantitative courses, it is recommended that CTBL is adopted in institutions of higher education that face the challenge of teaching courses of this type. Unfortunately, not all faculty members are familiar with the relevant topics of educational technology, especially the management of online courses in higher education.

In order to move forward, it may be useful to carry out training programmes so that lecturers will be familiar with the principles and practice of online courses management in higher education in general and the CTBL model in particular. Such knowledge can be purchased on the basis of the TMOC (Training for the Management of Online Courses) model (Ghilay, 2017a; Ghilay & Ghilay, 2014).

Larger implications of the study may be that existing students will be more successful, while other candidates will be able to attend the faculty teaching quantitative courses. Such courses are considered very difficult for many applicants and there are students who are unable to face the challenge. The adoption of the CTBL model may have significant social significance, as it may improve the accessibility of more and more students to higher education in general and to the scientific faculties in particular.

Researchers are invited to examine the model for other quantitative or non-quantitative courses and additional samples. In future, it is recommended to expand the sample of the model (82) in order to improve its validity. Additional studies may also focus on other disciplines such as language learning, especially English. This area also involves considerable difficulties among learners, especially those whose first language is not English. The CTBL model may also be significant in this context.

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