

Blended Learning Methods in Specialization Graduate Courses Improve the Knowledge Gain Metric

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Abstract

Information and communication technologies (ICT) have been proven beneficial in teaching of health sciences courses. Combined e-learning strategies with face-to-face activities, among others, are defining characteristics of a new learning perspective called blended learning methods. The paucity of data to confirm the benefits of online forms of learning, in isolation or as a part of a blended learning method, indicates that more studies are still required to assess their influence on the teaching-learning process. This study measured knowledge gained using face-to-face (FtFA) and distance educational on virtual learning environments (DA-VLE) strategies in health sciences. For two consecutive years, FtFA and DA-VLE education strategies were used in a discipline of specialization graduate course, each discussing two topics. The knowledge gained using each strategy was assessed for each topic using a pre (PT) and post-test (PoT). The performance frequency (PF) of participants was categorized based on the number of correct answers in each assessed. The PF frequency increased between the PA and PoT in both strategies (FtFA and - DA-VLE), although higher scores were observed in DA-VLE strategies when compared to FtFA strategies. These data indicate that such strategies, within this context, are vital, and can bring benefits to the teaching-learning process in combination.

Keywords: information technologies, e-learning, lectures, self-instructing, assessment, health professionals

1. Introduction

The teaching of medicine as we know today is the result of a reform process initiated in 1910 from the observations made by Flexner about teaching at that time (Prober & Health, 2012; Goudoris et al., 2013). However, more than 100 years after the publication of his report, this model has been proven fragile in the face of technological, scientific, and pedagogical advances achieved by the globalized world (Prober & Health, 2012). Some medical schools have thus implemented alternative teaching methodologies to the Flexnerian model such as the introduction of information and communication technologies (ICT) in the preparation of online courses (Prober & Health, 2012; Goudoris et al., 2013).

Information and Communication technologies (ICT) have expanded access to information through computers, newspapers, magazines and radio (Garcia & Carvalho Jr., 2015). In the teaching of medicine, ICT modify passive classroom teaching practices, engage students in the learning process and shorten time distances (Goudoris et al., 2013) mainly in areas with inadequate human and infrastructural resources like some African countries (Taye, 2014) as well as Brazil. ICT also assists in implementing online courses commonly referred to as e-learning, which use virtual learning environments (VLE) as teaching tools (Garcia & Carvalho Jr., 2015).

The term e-learning is defined by Ellaway (2011) as “A vaguely defined amalgam of information and communication technologies used in education, generally – but not exclusively – mediated by the internet in some way.” Teaching through this modality can be as effective as the traditional model (Reid et al., 2016; Cotič et al., 2016). Activities are conducted online and can be fulfilled synchronously or asynchronously by the participants (Garcia & Carvalho Jr., 2015). Its main benefits are the flexibilization of the student’s time, cost reduction, and functioning as a viable alternative to the permanent education process (Padalino & Peres, 2007; Lahti et al., 2014; Rocha, 2015; Samulsky et al., 2016).

Also in the context of online education there are VLE, defined as software corresponding to face-to-face environments (classroom) (Garcia & Carvalho Jr., 2015). They contain several activities (portfolios, tests, questionnaires) (Garcia & Carvalho Jr., 2015) that satisfactorily assist in knowledge acquisition. The application of ICT in training processes in health has been shown to be effective at multiple education levels such as undergraduate, graduate (master’s and doctorate; known in Brazil as *stricto sensu*) and specialization graduate courses (known in Brazil as *latu sensu*), continuing and extension education (Goudoris et al., 2013), and medical residency (Pinto et al., 2008) – included in the specialization category. Its use in undergraduate courses ranges from basic disciplines such as Anatomy (Acosta et al., 2018; Khalil et al., 2018), Histology (Santa-Rosa & Struchiner, 2011; Vasconcelos & Vasconcelos, 2013), and clinic (Gulat et al., 2019), to technical skills such as physical examination (Tenison & Touger-Decker, 2018), and even in the learning of professional ethics (Aguilar-Rodriguez et al., 2019). Other successful examples are also found in the field of continuing education (Oliveira et al., 2013), namely the use of the Moodle platform for working groups such as the Professor Development Program for Educators of the Health Professions of Instituto Regional FAIMER[®] Brasil (Garcia & Carvalho Jr., 2012).

The use of e-learning has crossed the boundaries of the most traditional teaching methodologies - lectures - and permeated the most active methodologies such as problem-based learning (PBL) (Chan et al., 2016; Shimizu et al., 2019), appearing in PBL as the strategy with the best academic performance (Ding & Zhang, 2018), and interactive narratives (Scamell & Hanley, 2017).

However, the existence of limitations must be considered such as in the case of the training of health professionals in clinical interventions for the results of knowledge and clinical behavior, and the clinical skills of health students, where the low quality of evidence does not allow firm conclusions on the relative efficacy of these training methods (Cook, 2009; Lahti et al., 2014; Mirmoghtadaie et al., 2016; Richmond et al., 2017). Despite the general interest on e-learning, critical reviews have cast suspicion on its effectiveness (Lahti et al., 2014; Mirmoghtadaie et al., 2016; Kyaw et al., 2019).

Although the use of ICT has proved beneficial in teaching health sciences through VLE and other methodologies (Santa-Rosa & Struchiner, 2011; Garcia & Carvalho Jr., 2012; Pereira et al., 2012; Rowe et al., 2012; Silva et al.; Vasconcelos & Vasconcelos, 2013; Vovides et al., 2014; Richmond et al., 2017), some unfavorable factors observed during its implementation ought to be highlighted. They are: institutional support, faculty involvement, student involvement, technical knowledge, support and infrastructure systems in which health sciences institutions ought to invest in while equipping human resources to utilize the technological infrastructure (Rowe, 2012; Han et al., 2014; Cotič et al., 2016). Other aspects are related to the student perception that online courses should only be complementary and not substitutes for traditional classes (Vasconcelos & Vasconcelos, 2013). Account must also be taken of the individual learning objectives (Nilsson et al., 2019) which are important in self-regulated learning (SRL) which emphasizes the autonomy and control by the individuals who direct, monitor, and regulate learning to achieve their goals and expertise. It has become increasingly a common theme in medical education over the last decade and plays a vital role not only during university years, but also when the students qualify and start practicing as doctors in the real world (Siddaiah-Subramanya et al., 2017).

Combined and asynchronous e-learning strategies (Baig et al., 2019), use of video recordings (Donkin et al., 2019), face-to-face activities among others, characterize blended learning, which allows new instructional methods and student-centered education to be used (de Jong, 2014), a developing strategy in terms of implementation.

There is limited information in the literature on the effects of e-learning strategies on the teaching-learning process. More studies are therefore needed to evaluate the effects of e-learning strategies – in isolation or as part of a blended learning program – on the teaching-learning process (Renno Junqueira et al., 2012; Vasconcelos & Vasconcelos, 2013; Harder, 2013). This study seeks to evaluate the effects of online education in a face-to-face specialization graduate course.

2. Methods

2.1 Study Classification and Participants

This is a quasi-experimental, descriptive, cross-sectional study conducted with students from the Clinical Analyses Specialization Graduate Course of Faculdade de Medicina de São José do Rio Preto (FAMERP), in 2016 and 2017, in the discipline Cellular Mechanisms of Reaction to Injuries - CMRI, with 50 students in total (2016 class: n=32; and 2017 class: n=18). This study was approved by the Research Ethics Committee, CAAE: 7631217.0.0000.5415.

2.2 Educational Strategies Used

Educational strategies in both classes were divided into 2 groups that were respectively called Face-to-Face Activities (FtFA) and Distance Activities in Virtual Learning Environment (DA-VLE). Two distinct topics were addressed in each of the strategies: FtFA: a) Routine Procedures for Biopsies and Surgical Parts (RPBSP) and b) Cell Adaptation to Injuries (CAI); and DA-VLE: a) Inflammation (I) and Hemodynamic Disorders (HD).

For the face-to-face (FtFA) strategy, the class topic was formally presented (formal class) by the professor using PowerPoint slides as an auxiliary device to the professor's speech. This class lasted 3 hours with a 20-minute interval for rest (Total duration: 3 hours and 20 minutes).

For the DA-VLE strategy, students had access to the PowerPoint slides on the subject (Study Material – SM) and to a study guide on a virtual platform (WIX[®]) available to them for a time interval equal to that of the FtFA strategy.

2.3 Assessment Procedures

The students undertook a knowledge assessment before (pre-test – PT) and after (post-test – PoT) exposure to each educational strategy to ascertain their background knowledge and their gained knowledge on the subject, respectively. The assessments consisted of 30 multiple choice questions, elaborated by a teacher other than the one who taught the topic. Additionally, the questions were the same in the PT and PoT of each topic but the students were unaware of this. The tests were performed immediately before and after the teacher's presentation and in a similar fashion for the virtual environment for comparability. The performance frequency (PF) was categorized into LOW (<10 correct answers), MEDIUM (10–20 correct answers) and HIGH (>20 correct answers).

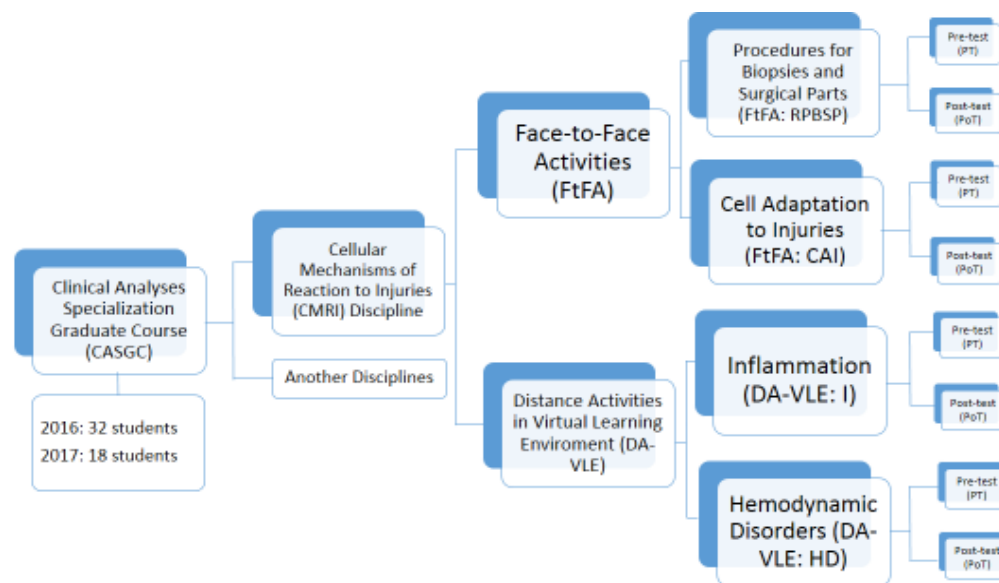


Figure 1. Illustrative scheme of educational strategies used and assessment procedures

2.4 Data Analysis

Data was presented as absolute numbers and percentages. The Chi Square test or Fisher's exact test were used to compare proportions. All tests were two-tailed and significance was considered when $P < 0.05$. Statistical analysis was performed using the StatsDirect software version 3.0.171.

3. Results

A total of 50 students were included in the study, all from the Specialization Graduate Course in Clinical Analyses of Faculdade de Medicina de São José do Rio Preto (FAMERP). The same students in each academic year (2016 and 2017) undertook assessments in the 4 different topics, however, the total number of assessments available for analyses from the 50 students was 182 (some of the 50 students did not complete all 4 topic assessments).

The pre-test of the students' knowledge in the FtFA and DA-VLE performed by PF in the studied topics showed that 78 students (42.8%) had low scores, 101 (55.5%) had medium scores, and only 3 (1.6%) had high scores. (Table 1). When comparing the two groups – FtFA and DA-VLE –, the analysis showed a similarity between groups with most scores in the low and medium ranges (Table 1).

After exposure to the educational strategies, the students showed higher frequency of scores in the moderate and high ranges (30.7% and 67.6%, respectively). Comparing the FtFA and DA-VLE groups, after the educational strategies students in the DA-VLE group showed a high level of knowledge when compared with the FtFA group (FtFA high scores=42% vs. DA-VLE high scores=89%; $p < 0.0001$) (Table 1).

Table 1. Performance frequency (PF) of students in pre (PT) and post-test (PoT) in face-to-face (FtFA) and distance activities (DA-VLE) in the topics assessments in the discipline, 2016 and 2017

PF PT	All (n=182)	FtFA (n=83)	DA-VLE (n=99)	p-value
Low [n(%)]	78 (42.8%)	38 (45.7%)	40 (40.4%)	0.54
Moderate [n(%)]	101 (55.5%)	43 (52%)	58 (58.6%)	0.89
High [n(%)]	3 (1.6%)	2 (2.4%)	1 (1%)	0.60
PF PoT	All (n=182)	FtFA (n=83)	DA-VLE (n=99)	p-value
Low [n(%)]	3 (1.6%)	3 (3.6%)	0	0.1
Moderate [n(%)]	56 (30.7%)	45(52.2%)	11 (11.1%)	<0.0001
High [n(%)]	123 (67.6%)	35 (42%)	88 (89%)	<0.0001

Observing the PF and comparing the PT and PoT results of FtFA students, the analysis shows that in both evaluated topics (CAI and RPBSP) the participants' performance was better on PoT (Table 2), and on the topics assessments in DA-VLE (I and HD) students also presented better performance on PoT (Table 3).

Table 2. Performance frequency (PF) of students in face-to-face activities (FtFA) in the topics assessment

FtFA (n=99)	PF	PT	PoT	p-value
I (n=50)	Low [n(%)]	14 (28%)	0	<0.0001
	Moderate [n(%)]	35 (70%)	6 (12%)	<0.0001
	High [n(%)]	1 (2%)	44 (88%)	<0.0001
HD (n=49)	Low [n(%)]	26 (53%)	0	<0.0001
	Moderate [n(%)]	23(47%)	5 (10.2%)	<0.0001
	High [n(%)]	0	44 (89.8%)	<0.0001

Table 3. Performance frequency (PF) of students in distance activities (DA-VLE) in the topics assessment

DA-VLE (n=83)	PF	PT	PoT	p-value
CAI (n=46)	Low [n(%)]	15 (32.6%)	3 (6.5%)	0.003
	Moderate [n(%)]	29 (63%)	17 (37%)	0.02
	High [n(%)]	2 (4.4%)	26 (56.5%)	<0.0001
RPBSP (n=37)	Low [n(%)]	23 (62.2%)	0	<0.0001
	Moderate [n(%)]	14(37.8%)	28 (75.7%)	0.002
	High [n(%)]	0	9 (24.3%)	0.002

Thus, although the PF between PT and PoT increased for both strategies (FtFA and DA-VLE), the increase was higher in the DA-VLE strategy when compared with FtFA (Tables 2 and 3).

4. Discussion

Given the advances presented by information and communication technologies in all sectors of society, combined strategies for teaching-learning can be used to respond to the needs of constant reform in education for health sciences. Such rapid advances in ICT have caused increasingly challenging and complex changes in pedagogical and andragogical strategies.

However, the transition from traditional learning to online learning is not free of challenges. Increasing time restrictions and demands are continually imposed on students and educators alike, driving educational institutions to find new ways to provide a more personalized and self-directed learning experience (O'Doherty et al., 2018).

Combined e-learning experiences with face-to-face education has increasingly attracted attention from educators, and has become an integral part of medical education strategies (Ruiz et al., 2006), especially with students widely embracing technology in their daily lives (de Leeuw et al., 2019).

This study compared face-to-face and distance education strategies and assessments content learning before and after the exposition of the proposed themes using performance frequency. The students' PF was evaluated in the FtFA and DA-VLE groups at both moments of the study: pre-test (PT) of their knowledge and after exposure to educational strategies (post-test – PoT). Our results show both groups had a knowledge gain in the PoT moment, considering that such PF increase is higher in the DA-VLE strategy when compared with FtFA one. Distance education was thus more responsive in our study. Chumley-Jones et al. (2002) show evidence about the benefits of e-learning, which in some cases is equivalent to or better than traditional learning, allowing greater acquisition of knowledge by the student. Moreover, the literature suggests higher rates of student satisfaction with e-learning, mainly due to its convenience, flexibility, and interactivity (Ruiz et al., 2006), allowing the user to control the content, learning sequence, pace and time chosen to study (Nilsson et al., 2019).

Sadeghi et al. (2014) reiterate that blended methods significantly increase the knowledge of students. Because student satisfaction and the cost-benefit ratio for the blended method are higher than in the formal method, we highly recommends that teachers use e-learning teaching methods as a complementary approach to theoretical teaching methods. This is corroborated by the results presented in our study since knowledge gain occurred in both educational strategies.

Health students need to assimilate new information during their studies, especially with the need for evidence-based practices; they also need to develop lifelong learning skills while keeping their knowledge updated and motivation for studies (Kim et al., 2016). Teaching strategies have thus evolved with changes in the conception of learning methods of traditional face-to-face teaching, seeking innovative methods that reorient the training of professionals towards the problematization of reality and integral health care (Lampert, 2008; Manoel, 2012).

E-learning can occur in several modalities, that is, in face-to-face, blended, and virtual environments (Kim et al., 2016). Our study used a virtual learning platform (WIX[®]), i.e., we used technological resources to support the discipline, and such virtual scenario stimulated learning significantly. In a scenario where digital globalization and content problematization become vital for students to acquire knowledge in learning processes, information and communication technologies in virtual environments enable student emancipation in the face of the development of individual skills; we thus enter the field of self-regulated learning, which is described as being directed by one monitoring their own learning needs and using the instruments necessary to support the learning process (Lycke et al., 2006; Sandars & Cleary, 2011; Vermut & Donche, 2017). Self-regulated learning theories shed light on incentives and approaches of students regarding

flexible learning tools (Winters et al., 2008; Devolder & van Braak, 2012).

All innovation can be exciting as a novelty, and the innovations brought about by e-learning in the distance activities of our study used as a complementary resource based on a VLE contributed to the learning of students based on self-regulated learning principles, in which students make their decisions based on several factors, including individual strategies to regulate their learning. One of the comprehensive aspects of this resource is its relationship with individual learning goals (Nilsson et al., 2019).

The main limitations of this study are its limited sample size, the specific studied topics and the identical pre and post-test questions. Nevertheless, we believe the results of this study contribute to reflections on the importance of distance education models and the integration of technologies and virtual learning environments to face-to-face health education. This study also contributes information on the effectiveness of pre- and post-tests as an assessment strategy for knowledge gain. We recommend that future studies be conducted with different sets of pre and post-test questions testing the same concepts in knowledge acquisition to enhance validity. We must note that although the knowledge gain measure is restricted to the cognitive component, this component is necessary for the development of competences, a concept that since 1956 took on the world from Benjamin Bloom, whose taxonomy of educational objectives includes the cognitive domain (knowledge), psychomotor domain (skills), and affective domain (attitudes) (Bloom et al., 1956).

Although the physical distance between professors and students and communication using media are a challenge for educational institutions due to requiring investments on technologies and changes in the culture of professors and students – who are accustomed to the face-to-face learning model (Mugnol, 2009), and that much still needs to be elucidated about self-regulated learning, the conclusions of this investigation can serve as the basis for further studies aimed at improving the teaching-learning process in the different teaching modalities, and paraphrasing Siddaiah-Subramanya et al.: “Self-regulated learning is vital throughout life in the current era. Learning how to learn is critical. It is under the influence of intuitions and beliefs, which can harm the process or increase effectiveness. Becoming a sophisticated learner requires basic understanding of the learning process, identifying and interpreting errors and avoiding the mentality that one’s learning capacity cannot change; encouraging the mind to think freely and appreciate the incredible human capacity” (Siddaiah-Subramanya et al., 2017).

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