ORIGINAL ARTICLE

Real Time Electronic Formative Assessment in Medical Education and Its Impact on Motivational Beliefs and Self-regulation Strategies

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قياس التكوين الإلكتروني في الوقت الحقيقي في التعليم الطبي وأثره على المعتقدات التحفيزية وإستراتيجيات التنظيم الذاتي

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Background and Objectives: The aim of this study was to investigate the effect of real-time electronic formative assessment-based medical education on learners' motivational beliefs and self-regulation strategies.

Methods: This randomized clinical trial was conducted on 323 students studying at the Medical School of Mashhad University of Medical Sciences, Mashhad, Iran, during the first semester of the academic year of 2017-2018 using a posttest control group design. The investigation of motivational beliefs and self-regulation strategies was accomplished using the Motivated Strategies for Learning Questionnaire. The research hypotheses were studied by means of independent t-test and multivariate analysis of variance.

Results: According to the results, there was a significant difference between the control and intervention groups in terms of motivational strategy subscales, namely self-efficacy, intrinsic value, test anxiety, and self-regulation (P<0.05). In this regard, the intervention group showed higher mean scores in motivational beliefs and self-regulation strategies, compared to the control group. However, no significant difference was observed between the two groups regarding the mean cognitive strategies (P>0.05).

Conclusion: As the findings indicated, the use of real-time electronic formative assessment in the educational environment can enhance students' motivational beliefs and self-regulation strategies in medical education.

Keywords: Formative Assessment, Electronic Assessment, Real-Time Electronic Formative Assessment, Motivated Strategies for Learning, Medical Education

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الأرضية والهدف : تهدف هذه الدراسة إلى تقييم تأثير القياس التكويني الإلكتروني على المعتقدات التحفيزية وإستراتيجيات التنظيم الذاتي في تعليم الطب .

الطريقة : في هذا التحقيق تمت الدراسة السريرية بطريقة عشوائية . من أجل تقييم المعتقدات التحفيزية وإستراتيجيات التنظيم الذاتي تم اختيار ورقة أسئلة إستراتيجيات التحفيز من أجل التعليم وتم تقييم الفرضيات عن طريق اختبار t المستقل وتحليل وواريانس المتعدد .

النتاج: لقد أظهرت النتائج إختلافاً واضحاً بين مجموعات المشاهدة و مجموعات تحت التجربة في معدل العلامات في مقياسات العمل والقيم الداخلية والإضطراب الإمتحاني والتنظيم الذاتي ،وكان p>٠.٠٥. لذلك إن الناتج يشير إلى أن فرضيات التحقيق مبنية على الفقائد التحريضية والإستراتيجيات التنظيمية الذاتية للطلاب الذين كانوا عرضة إلى نمط التعليم في محيط يعتمد على القياس التكوين الإلكتروني أفضل من الطلاب الذين لم يكونوا تحت هذا النمط من التعليم وكان مقياس الصحة ٩٥٪. أما بالنسبة لمعدل مقياس إستراتيجيات المعرفة لم يكن هناك اختلاف واضح وكان p>0.05 بين مجموعتي المشاهدة والدراسة .

النتيجة: إن وظيفة القياس التكويني الإلكتروني في الوقت الحقيقي في الوسط التعليمي يستطيع تقوية المعتقدات التحفيزية واستراتيجيات التنظيم الذاتي للطلاب في مجال التعليم الطبي.

الكلمات الدليلية : القياس التكويني ، القياس الإلكتروني ، القياس التكويني الإلكتروني في الوقت الحقيقي ، الإستراتيجيات التحفيزية للتعليم ، تعليم الطب .

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سنجش تکوینی الکترونیکی بلادرنگ در آموزش پزشکی و بررسی تأثیر آن بر باورهای انگیزشی و راهبردهای خودتنظیمی

زمینه و اهداف: هدف از این مطالعه بررسی تاثیر سنجش تکوینی الکترونیکی بلادرنگ بر باورهای انگیزشی و راهبردهای خودتنظیمی در آموزش پزشکی می‌باشد.

روش بررسی: در این پژوهش از طرح کارآزمایی بالینی تصادفی شده استفاده گردید. جهت بررسی باورهای انگیزشی و راهبردهای خودتنظیمی پرسشنامه راهبردهای انگیزشی برای یادگیری مورد استفاده قرار گرفت. از آزمون‌های t مستقل و برای تحلیل واریانس چند متغیره (پنج متغیر وابسته) با یک متغیر مستقل با نام عامل گروه‌بندی MANOVA به منظور بررسی فرضیه‌های پژوهش استفاده شد.

یافته‌ها: نتایج نشان می‌دهد که میانگین نمره‌های خرده مقیاس‌های خود کارآمدی، ارزش‌گذاری درونی، اضطراب امتحان و خودتنظیمی در بین گروه‌های آزمایش و کنترل تفاوت معنی‌داری با یکدیگر دارند (P<۰/۰۵). به عبارت دیگر نمرات گروه آزمایش در این خرده مقیاس‌ها از گروه کنترل بهتر است. بنابراین نتایج آزمون MANOVA نشان می دهد که با ۰/۹۵ درصد اطمینان فرضیه پژوهش مبنی بر این که میزان راهبردهای انگیزشی برای یادگیری در دانشجویانی که در معرض الگوی محیط یادگیری مبتنی بر سنجش تکوینی الکترونیکی بلادرنگ قرار می‌گیرند بیشتر از دانشجویانی است که در معرض این الگو قرار نگرفته‌اند، مورد تایید قرار می‌گیرد. اما میانگین خرده مقیاس راهبردهای شناختی در بین دو گروه آزمایش و کنترل تفاوت معناداری را نشان نداد (P>۰/۰۵).

کلمات کلیدی: سنجش تکوینی، سنجش الکترونیکی، بلادرنگ، سنجش تکوینی الکترونیکی بلادرنگ، راهبردهای انگیزشی برای یادگیری، آموزش پزشکی

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سنجش تکوینی الکترونیکی میڈیکل تعلیم میں رینڈم طریقے سے طلباء کی تعلیم میں پیشرفت اور تعلیمی روشوں کا الیکٹرانک ذرائع سے جائزہ لینا اور اس بات کی جانچ کرنا کہ یہ روش تعلیمی محرکات اور خود کو منظم کرنے کی حکمت عملی پر کیسے اثر انداز ہوتی ہے۔

بیک گراونڈ: اس تحقیق کا ہدف یہ ہے کہ ہم میڈیکل تعلیم میں پیشرفت اور تعلیمی روشوں کا جائزہ لیں اور یہ دیکھیں کہ تعلیم طب میں یہ روش تعلیمی محرکات اور خود کو منظم کرنے کے عمل پر کس طرح سے اثر انداز ہوتی ہے۔

روش: اس تحقیق میں ہم نے رینڈم طریقے سے کلینیکل سطح پر میڈیکل طلباء کا امتحان لیا۔تعلیمی محرکات نیز خود کو منظم کرنے کے اصولوں کی افادیت کا جائزہ لینے کےلئے ہم نے ایک سوالنامہ تیار کیا تھا جس میں تعلیمی معیار کو بڑھانے کےلئے محرکات کے بارے میں سوال کئے گئے تھے، اس میں پیش کئے گئے مفروضات کا تجزیہ مستقل ٹی ٹسٹ اور ویری اینس اینالائسس سے کیا گیا۔

نتیجہ: حاصل شدہ نتائج کے مطابق ہمیں یہ معلوم ہوتا ہے کہ کنٹرول گروپ اور انٹریشن گروپ میں، خود سے اپنے تعلیمی اقدامات کو اہمیت دینا، امتحان کے پیش نظر اضطراب اور خود سے بہتر اصولوں کو اپنانے جیسے امور کے درمیان کافی فرق دکھائی دیا۔

جن طلباء کی علمی پیشرفت کا اور تعلیمی روشوں کا الیکٹرانک ذرائع سے جائزہ لیا گیا تھا ان کی تعلیمی کارکردگی ان طلباء سے بہتر تھی جن کا جائزہ سادہ روشوں سے لیا گیا تھا۔ہم اس نئی روش کو پچانوے فیصدی اطمینان سے استعمال کرسکتے ہیں۔

سفارش: چونکہ ایفر میثیورینڈم روش طلباء کے لئے مفید واقع ہوتی ہے اور اس سے ان کی خود اعتمادی بڑھتی ہے اس سے کام لیاجانا چاہیے۔

کلیدی الفاظ: الیکٹرانک جائزہ، رینڈم، تعلیمی محرکات، میڈیکل طلباء۔

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INTRODUCTION

Assessment is one of the important steps in any teaching-learning process [1, 2]. Brown and Knight consider assessment as the heart of student learning experience [3]. In new learning theories, classroom assessment is recognized as an important element in both teaching and learning processes [4, 5]. According to Butler and Mcmunn (2006), assessment can be distinguished under three types of diagnostic, formative, and summative, which date back to Scriven (1967) who first made the distinction [6].

Formative assessment is defined as a continuous process of monitoring the learners' progress in obtaining knowledge [7]. In another definition, this kind of assessment is defined as "the process of seeking and interpreting evidence for the use by learners and teachers to decide where the learners are in their learning, where they need to go, and how best to get there" [8]. New learning environments are targeted toward the establishment and development of a deep and meaningful learning approach in students [9, 10]. In such learning environments, students have an active, constructive, self-regulated, targeted, and collaborative role, who engage themselves in these environments with the goal of self-promotion [11].

Formative assessment has a positive effect on the learner empowerment and learning self-regulation by helping students to find their strengths and weaknesses [12, 13]. On the other hand, the reduction of learning motivation in medical students is a challenge that has been considered in the recent years. Formative assessment can be used as an option for the enhancement of learner's motivation.

According to some evidence, the use of formative assessment, along with the summative assessment, can improve the quality of education, increase the learning motivation, and improve self-regulation learning in students [13]. In the same vein, Faber et al. reported that the use of electronic formative assessment tools exerts a positive impact on learners' academic achievement and motivation [14].

The advancement of technology has resulted in the establishment of many educational opportunities in the learning environments. One of these tools is the real-time electronic system in the classroom [15]. These technologies facilitate recurring opportunities for students to practice. Electronic formative assessment cannot only involve and motivate students, but also help them monitor their progress and learning speed [16]. These systems enjoy many merits, such as improvement of attention, enhancement of knowledge acquisition, possibility of performing secret surveys, tracking of individual responses, instant display of the responses of questions, creation of an interactive and entertaining learning environment, collection of information for reporting, and implementation of analysis [17].

It should be also noted that such assessments motivate the learners to reflect, discuss, and participate in the learning process [18]. One of the major challenges in the field of medical education is that in large classes, it is difficult to achieve high and acceptable lecturing standards and present materials while involving the students and increasing their participation and academic engagement. Individual response technology encourages active learning [19] and leads to the activation of higher levels of cognition in students.

It should be noted that motivation is one of the most important determinants of learning quality and success. Accordingly, the lack of this construct can well explain such questions as why professors sometimes encounter with discouraged students or learners who have lost their interest or have abandoned their studies and activities, as well as why sometimes the students feel weak or abandoned [20]. One of the objectives of the university environment is to encourage the students to engage in a social, sustainable, and non-threatening environment [21]

The medical education researchers should give special attention to the concept of motivation [20]. However, the mechanisms through which learners adjust their motivation and learning strategies are not fully understood yet [22]. According to Borman and Sleigh, learners can be significantly engaged in the learning environments by means of non-summative marking systems [23]. Electronic methods for feedback presentation can be also developed automatically and continuously to support learners' engagement in learning [15].

According to the literature, real-time electronic formative assessment facilitates the learners' active participation in the learning environment and allow them to receive immediate feedback [21]. The technique investigated in this study specifically modifies the role of students from a passive position to the condition in which students take the responsibility of their learning process and seek to improve the process through active participation in the learning environment. The present study aimed to find a strategy to support and guide learners in real time [24].

This study also attempted to find out how electronic formative assessment could be provocative for learners. To this end, a learning environment was designed based on real-time electronic formative assessment that involved gamification elements as motivational aspects in the process of teaching and learning. Gamification refers to the mechanical and artistic application of ideas and aesthetic components of games (e.g., context, immediate feedback, competition, stages, achievements, and points) to engage the learners in the problem and motivational activities and promote their learning and problem solving ability [25]. Generally, the purpose of the present study was to investigate the effect of real-time electronic formative assessment-based medical education on students' motivational beliefs and self-regulation strategies.

METHODS

This randomized clinical trial was conducted on 323 students studying at the Medical School of Mashhad University of Medical Sciences, Mashhad, Iran, during the first semester of the academic year of 2017-2018 using a posttest control group design. The research hypotheses were as follows:

a) Students exposed to real-time electronic formative assessment-based learning model have a higher motivational belief score, compared to the non-exposed students.

b) Students exposed to the real-time electronic formative assessment-based learning model have a higher self-regulation

strategies score, compared to the non-exposed students.

Study population and sampling

The study population corresponded to a group of 323 students selected from 1,620 MD students studying at Mashhad University of Medical Sciences using convenience sampling technique. The participants were randomly divided into two groups of intervention (n=159) and control (n=164).

Research process

Given that the difficulty of the educational content of each lesson could disturb the results of the study, there was a need to homogenize this variable. Regarding this, based on the opinions of the relevant experts and professors, the lessons of histology and trunk anatomy, which were similar in terms of difficulty level, were selected from the basic science courses for general medical students. The sessions were divided into two groups of control and intervention.

After the determination of the control and intervention groups, in the intervention sessions, real-time electronic formative assessment was adopted during the teaching process. In this regard, during each session, the instructor asked questions regarding the educational content taught at the same session in the form of PowerPoint slides. The students used keypads to answer the questions.

Based on the rate of the correct answers, the professor instantly (in the real time) decided on continuing the discussion or re-explaining the subject to resolve the gap between what is gained by the students and what they should know. In the control group, the sessions were implemented using the routine educational approach. At the end of the course, the two groups filled out the Motivated Strategies for Learning Questionnaire (MSLQ) developed by Pintrich and DeGroot (1990) [26]. This questionnaire measures the students' motivational beliefs and self-regulation strategies. The MSLQ consists of two main sections, namely motivational beliefs (including three subscales of self-efficacy, intrinsic value, and test anxiety) and self-regulation strategies (including two subscales of cognitive and self-regulation strategies).

Statistical analysis

Regarding the fact that the education was performed by two different lecturers in the control and intervention groups, the educator factor was in interaction with educational method; therefore, the design of the study could be considered with two independent variables. Therefore, a preliminary analysis was carried out separately, considering the roles of the teaching method and educator as independent variables in the subscales of motivational strategies for learning to use the independent t-test.

The results indicated that the intervention group exposed to the real-time electronic formative assessment-based learning showed higher mean scores in self-efficacy, intrinsic value, and self-regulation than the control group (P<0.05). In addition, the intervention group had a lower test anxiety mean score, compared to the control group (P<0.05). The only subscale that was not significantly different between the two groups was cognitive strategies (P>0.05). However, the investigation of educator factor as an independent variable revealed no significant difference between the two lecturers in terms of motivational strategies for learning. The performance of the two groups was comparable regardless of the grouping factor (i.e., lecturer) (P>0.05). Therefore, due to observing no difference in the subscales when considering the educator factor, this factor was ignored in all analyses of motivational strategies for learning subscales.

Since the five components (i.e., self-efficacy, test anxiety, intrinsic value, cognitive strategies, and self-regulation strategies) under study were aggregated in one scale, the separate analysis of the major two components (i.e., motivational beliefs and self-regulation strategies) was avoided, and they were analyzed collectively. Consequently, the research hypotheses were tested using the multivariate analysis of variance (MANOVA) with five dependent variables and one independent variable, namely teaching method.

RESULTS

The distribution of the data related to motivational strategies for learning was tested using skewness and kurtosis. In addition, the Kolmogorov-Smirnov test was employed to investigate the normality of the data.

Table 1 tabulates the descriptive statistics and normality of the data related to motivational strategies for learning. As

Subscale \ Statistics	Range	Minimum	Maximum	Mean	Standard error of mean	Standard deviation	Variance	Skewness	Standard error of skewness	Kurtosis	Standard error	Kolmogorov-Smirnov	P-value
Self-efficacy	28	17	45	33.89	0.30	4.99	24.99	-0.32	0.148	0.34	0.29	1.86	0.002
Intrinsic value	34	26	60	47.34	0.36	5.72	32.76	-0.46	0.153	0.99	0.30	1.22	0.10
Test anxiety	24	6	30	17.63	0.29	4.84	23.44	0.12	0.148	-0.43	0.29	1.43	0.04
Cognitive strategies	38	42	80	60.62	0.41	6.64	44.11	0	0.152	0.83	0.30	1.33	0.06
Self-regulation	12	8	20	14.98	0.14	2.23	4.99	-0.37	0.151	0.31	0.30	2.35	0.0001

Table 1. Descriptive statistics and normality of motivational strategies for learning

Table 2. Effect of real-time electronic formative assessment-based learning environment on the subscales of motivational strategies for learning				
	Research groups			
Subscale	**Intervention group**	**Control group**	**F**	**P-value**
	Mean±SD	Mean±SD		
Self-efficacy	35.01±4.48	32.80±5.25	12.57	0.0001
Intrinsic value	48.76±5.26	45.87±5.83	16.57	0.0001
Test anxiety	16.74±4.76	18.50±4.78	8.30	0.004
Cognitive strategies	61.06±6.36	60.19±6.92	0.43	0.51
Self-regulation	15.29±2.11	14.66±2.32	5.47	0.02

indicated in this table, the dependent variable had a normal distribution in the subscales of motivational strategies for learning. It should be noted that the variables whose normality was not confirmed by the Kolmogorov-Smirnov test were evaluated using the skewness and kurtosis. Given the fact that there were five subscales in motivational strategies for learning and given the interdependence of these subscales, MANOVA was used to study the hypotheses considering the educational method as the independent variable.

Table 2 presents the results of MANOVA. The results indicated a significant difference between the intervention and control groups in terms of the mean scores of self-efficacy, intrinsic value, test anxiety, and self-regulation strategies ($P < 0.05$). In this regard, the intervention group had higher mean scores in these subscales, compared to the control group. The results of MANOVA also revealed that the motivational strategies in the students exposed to the real-time electronic formative assessment-based learning were at a more favorable level, compared to those in the students, who were not subjected to this educational model with 95% confidence interval. However, no significant difference was observed between the two groups regarding the subscale of cognitive strategies ($P > 0.05$).

DISCUSSION & CONCLUSION

The findings of this study revealed a significant difference between the intervention and control groups regarding the mean self-efficacy, intrinsic value, test anxiety, and self-regulation. In other words, the intervention group, exposed to a real-time electronic formative assessment-based learning environment, showed more favorable outcomes in terms of these subscales, compared to the control group. However, no significant difference was observed between the two groups considering the mean score of cognitive strategies. This finding can be due to the fact that the induction of a change in the cognitive strategies of the students requires implementing the intervention for a longer period of time.

In general, the findings of the present study are in line with those obtained by Ghazi and Henshaw (1998), Black et al. (2003), Nazari and Osareh (2011), Weurlander et al. (2012), Ludvigsen et al. (2015), Faber et al. (2017), and Georgoff et al. (2018) [14, 27-32]. Clark (2012), investigating formative

assessment and its impact on self-regulation learning, introduced this method as a part of learning activities that improves self-regulation learning [33]. Likewise, Pilli and Aksu (2013) found that electronic formative assessment tools exert a positive effect on learners' attitudes [34].

On the other hand, our findings are inconsistent with the results obtained by Muis et al. (2015) reporting negative impacts of electronic formative assessment on the motivation of five-year-old children [35]. A possible explanation for this finding can be related to the effects of negative feedback on learners' motivation. Hunsu et al. (2016) also indicated the positive effects of audience response system on non-cognitive learning outcomes, such as student engagement, participation, and interest [36]

In general, studies have shown that the use of formative assessment in the implementation of educational courses facilitates the learner to turn from a passive learner to an active one who is responsible for his/her own learning. It seems that the use of electronic formative assessment in classrooms can enhance students' motivation for learning and strengthen self-regulation learning in them. As the literature indicated, the use of formative assessment, along with summative assessment, leads to the improvement of education quality, enhancement of motivation for learning, and reinforcement of self-regulation learning in students.

ACKNOWLEDGEMENTS

Ethical considerations
In line with the research ethics principles, informed consent was obtained from all participants. Furthermore, the participants were ensured about the anonymity terms; accordingly, their scores were used through coding. The present study was ethically approved by the Research Committee.

Conflicts of interest
There are no conflicts of interest in this study.

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