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### The Effectiveness of Concept Map instruction in mobile phones on Creativity of Nursing Students in Intensive Care Course

**Background:** technology-based concept mapping is a subset of e-learning and is considered a selective strategy for providing information and educational skills. The aim of this study was to investigate the effectiveness of concept mapping instruction in mobile phones on the creativity of nursing students.

**Methods:** This study was a pretest posttest randomized controlled trial. Sixty eight senior nursing students were selected using the whole enumeration. They were divided equally into the experimental (n=34) and control groups (n=34) by stratified block randomization. In the experimental group, concept mapping instruction was carried out using mobile phones; however, the routine method was used in the control group. Students' creativity was measured by Abedi's Creativity Test before and after the intervention. Data were analyzed with SPSS software using the paired t-test and multivariate analysis of covariance.

**Results:** There was no significant difference between the two groups in terms of demographic characteristics ( $p > 0.999$ ). The mean total creativity score and the mean scores on all the subscales decreased in both groups in comparison to the pre-intervention scores. The changes in the scores of elaboration ( $p = 0.046$ ), originality ( $p = 0.022$ ), and total creativity ( $p = 0.036$ ) showed a significant difference between the control and experimental groups, but there was not any significant difference between two groups in term of fluency ( $p = 0.08$ ) and flexibility ( $p = 0.143$ ).

**Conclusion:** Although the easy access of learners to mobile phones made the use of this approach seem useful in students' education, further studies are recommended with higher sample sizes and other creativity assessment instruments.

**Keywords:** Concept mapping, Creativity, Mobile phone, Nursing, Students

### فاعلية التدريب بالجوال على اسلوب خريطة المفهوم في إبداع طلاب التمريض في دورات العناية المركزة

**الخلفية والهدف:** مع الأخذ في الاعتبار أن رسم خريطة المفاهيم بمساعدة التكنولوجيا هو مجموعة فرعية من التعلم الإلكتروني ويعتبر استراتيجية اختيارية لتوفير المعلومات ومهارات التدريس في التعليم. لذلك أجريت هذه الدراسة لتحديد أثر التدريب على خريطة المفاهيم بالهواتف المحمولة على إبداع طلاب التمريض في فترات التدريب في مجال العناية المركزة.

**الطريقة:** الدراسة الحالية عبارة عن تصميم شبه تجريبي المتحكم من مجموعتين عشوائيتين مع الاختبار القبلي والبعدي. تم اختيار 68 طالب تمريض في السنة الرابعة بطريقة التعداد وتم توزيعهم عشوائياً على مجموعتي التدخل (العدد = 34) والمجموعة الضابطة (العدد = 34). تم تنفيذ تعليمات تخطيط المفاهيم باستخدام الهواتف المحمولة في المجموعة التجريبية واستخدام الطريقة الروتينية في المجموعة الضابطة. تم قياس إبداع الطلاب من خلال اختبار الإبداع الذي أجراه "السيد عابدي" قبل التدخل وبعده. تم تحليل البيانات باستخدام برنامج SPSS باستخدام اختبار t المقترن والتحليل متعدد المتغيرات للتغاير.

**النتائج:** لم يكن هناك فرق معتمد بين المجموعتين من حيث المتغيرات الديموغرافية ( $p > 0.999$ ) وكان متوسط درجة الإبداع الكلي وجميع المقاييس الفرعية في كلا المجموعتين أقل مما كان عليه قبل التدخل. كان متوسط درجة المقاييس الفرعية للتوسع ( $p = 0.046$ ) والمبادرة ( $p = 0.022$ ) ودرجة الإبداع الكلي ( $p = 0.036$ ) مختلفة بشكل كبير بين مجموعات التدخل ومجموعة التحكم، ولكن من حيث المقاييس الفرعية للسؤال ( $p = 0.080$ ) والمرونة ( $p = 0.143$ ) لم يلاحظ أي فرق معتمد به إحصائياً.

**الخلاصة:** على الرغم من أن الموقف الإيجابي وسهولة وصول المتعلمين إلى الهواتف المحمولة يجعل استخدام هذه الطريقة مفيداً في تعليم طلاب التمريض، إلا أنه يوصى بإجراء مزيد من الدراسات مع حجم عينة أكبر وأدوات أخرى لقياس الإبداع.

**الكلمات المفتاحية:** خريطة المفاهيم، الهاتف المحمول، الإبداع، الطلاب، التمريض

### اثربخشی آموزش به روش نقشه مفهومی با تلفن همراه بر خلاقیت دانشجویان پرستاری در کارورزی مراقبت ویژه

**زمینه و هدف:** با توجه به اینکه ترسیم نقشه مفهومی با کمک تکنولوژی زیرمجموعه‌ای از آموزش الکترونیک و به‌عنوان یک استراتژی انتخابی برای ارائه اطلاعات و مهارت‌های تدریس در آموزش در نظر گرفته شده است. لذا این پژوهش با هدف تعیین تأثیر آموزش نقشه مفهومی با تلفن همراه بر خلاقیت دانشجویان پرستاری در کارورزی مراقبت ویژه صورت پذیرفت.

**روش:** مطالعه حاضر از نوع کارآزمایی کنترل شده تصادفی دو گروهه با طرح پیش‌آزمون - پس‌آزمون است. 68 نفر از دانشجویان سال چهارم پرستاری به روش کل شماری انتخاب و با تخصیص تصادفی بلوک بندی طبقه ای به دو گروه مداخله (تعداد=34) و کنترل (تعداد=34) تخصیص یافتند. در گروه مداخله، آموزش به روش نقشه مفهومی با تلفن همراه و در گروه کنترل تدریس به روش سنتی ارائه شد. خلاقیت فراگیران قبل و بعد از مداخله با "آزمون سنجش خلاقیت عابدي" سنجیده شد. تحلیل داده‌ها با کمک آزمون تی زوجی و تحلیل کوواریانس چند متغیره و با استفاده از نرم افزار SPSS انجام شد.

**یافته‌ها:** بین دو گروه از نظر متغیرهای دموگرافیک تفاوت معنی داری وجود نداشت ( $p > 0.999$ ). میانگین نمره کل خلاقیت و کلیه خرده مقیاس‌ها در هر دو گروه نسبت به قبل از مداخله کاهش داشت. میانگین نمره خرده مقیاس‌های بسط ( $0.046$ )، ابتکار ( $p = 0.022$ ) و نمره کل خلاقیت ( $p = 0.036$ ) بین دو گروه مداخله و کنترل تفاوت معنی داری داشت اما از نظر خرده مقیاس‌های سیالی ( $p = 0.080$ ) و انعطاف پذیری ( $p = 0.143$ ) تفاوت آماری معناداری مشاهده نشد.

**نتیجه گیری:** گرچه نگرش مثبت و دسترسی آسان فراگیران به تلفن همراه، استفاده از این شیوه را در آموزش دانشجویان پرستاری مفید جلوه می دهد، اما انجام مطالعات بیشتر باحجم نمونه بالاتر و با سایر ابزارهای سنجش خلاقیت پیشنهاد می گردد.

**واژه های کلیدی:** نقشه مفهومی، تلفن همراه، خلاقیت، دانشجویان، پرستاری

### اسمارت تلفنوں کے ذریعے کانسپٹ میپنگ کی روش سے آئی سی یو نرسنگ طالبات کی تخلیقی صلاحیتوں میں اضافہ - ایک جائزہ

**بیک گراؤنڈ:** جدید تکنالوجی کے ذریعے کانسپٹ میپنگ کی روش الیکٹرانیک ذریعہ تعلیم کی ایک ذیلی شاخ ہے تاہم اس روش سے طلبا و طالبات کو معلومات فراہم کر کے انہیں تعلیمی مہارتیں سکھائی جاتی ہیں۔ اس تحقیق کا هدف یہ جاننا ہے کہ اسمارٹ فون سے کانسپٹ میپنگ آئی سی یو کی نرسنگ اسٹوڈنٹس کی تعلیم میں کس طرح مفید واقع ہوسکتی ہے۔

**روش:** اس تحقیق میں پری ٹسٹ اور پوسٹ ٹسٹ کی روش اختیار کی گئی۔ نرسنگ کے اسٹوڈنٹس کو جن کا تعلق چوتھے سال سے تھا اس تحقیق میں شریک کیا گیا۔ پھر ان کے دو گروہ یعنی آزمائشی اور کنٹرول گروپ میں بانٹا گیا ہر گروپ میں چونتیس طلبا تھے۔ آزمائشی گروہ کو اسمارٹ موبائل فون کے ذریعے کانسپٹ میپنگ کے تحت تعلیم دی گئی۔ کنٹرول گروپ کو روایتی انداز سے تعلیم دی گئی۔ دونوں گروپوں کی کارکردگی کا عابدی تخلیقی ٹسٹ کے ذریعے جانچ کی گئی اور ڈیٹا کا تجزیہ ایس پی ایس ایس ایس سافٹ ویئر ٹسٹ اور کوویریانس اینالائسس سے کیا گیا۔

**نتیجے:** دونوں گروپوں میں ڈیموگرافک خصوصیات کے لحاظ سے کوئی خاص فرق نظر نہیں آیا۔ البتہ تخلیقی صلاحیتوں کے بارے میں آزمائشی اور کنٹرول گروپ میں خاصہ فرق دکھائی دیا۔

**سفارش:** اگرچہ اسمارٹ موبائل فون طلباء کو آسانی سے دستیاب ہے تاہم مزید بڑی تحقیقات اور دیگر تجزیاتی وسائل سے طلباء کی تخلیقی صلاحیتوں کا جائزہ لینے کی ضرورت ہے۔

**کلیدی الفاظ:** میپنگ روش، اسمارٹ فون، تخلیقی صلاحیتیں

## INTRODUCTION

Modern educational systems should train learners to be able to understand today's complex world and be creative (1). In recent literature, the importance of innovation and creativity as a key element of learning is emphasized in the twenty first century (2). Creativity is an essential component of nursing care and its development is a priority (3).

Asurakkody and Shin (2018) pointed to the role of creativity and innovation in enhancing the ability of the health care system, as well as developing new treatment approaches and procedures (4). In addition to the importance of creativity and innovation as vital components of maintaining and improving the quality of nursing care (5), the results of qualitative study of Isfahani et al. (2015) showed that nursing creativity leads to major changes in nursing and organizational performance (6). According to them, policymakers, managers, and nursing educators should provide a suitable environment for fostering creativity. Therefore, students need to increase their creativity in order to think in a new way and move towards a developed society (7).

Despite the importance of creativity, the findings of a systematic review by Chan implied that traditional methods of teaching practical skills hinder students' creativity. Therefore, nursing education should help develop problem-based learning and promote creativity in the learners through using novel educational methods (8). As an educational method that enhances the creative skills of learners, concept mapping is considerably acceptable in education (9). The conceptual map is a set of concepts in a systematic framework and a hierarchy order by providing a logical link between them at different level (10). Several studies have been conducted on concept mapping and its impact on variables including clinical learning (11), scientific literacy (12), and clinical decision-making skills (13) among different groups of medical and paramedical students. Studies have also shown that concept mapping can be used as an effective learning strategy (14), in addition to the positive effects of the use of concept mapping on cognitive processes such as data retention and retrieval (15), and creativity (16).

In most cases, reported research results indicate the concept mapping is effective in improving students' learning. Most studies have emphasized the use of traditional pen-and-paper concept mapping as an educational method and the use of pen and paper seems to have been the most natural way to create concept maps. But students are expected to find information as quickly as possible. So the days of pen and paper in classes have come to an end (17). On the other hand, education is in a transition period, and teachers are turning from paper-based classrooms to technology-integrated classrooms (18). Educational experts believe that traditional learning approaches cannot meet the needs and challenges that have emerged as a result of new technologies (19). Some have suggested that computer-based concept mapping is a more efficient way to create concept maps. The simplicity of designing, drawing, and revising concept maps, the ease of organizing information and using a variety of

templates for concept maps, and the sharing of concept maps are among the benefits of making use of software in comparison to the pen-and-paper method (20).

a model of e-learning through mobile technologies such as cell phones, e-books, and so on. This type of learning provides access to the learning content with greater ease (23). Kusnekoff et al. acknowledged that if mobile learning is in line with educational objectives, it can have a positive impact on the students' learning process (14). Since today's students have access to cell phones, working with and using applications for several hours a day is very popular among them (21).

In addition to the benefits mentioned above, there is evidence of satisfaction with the use of cell phones among learners. In a study by Mao (2014), 76% of Chinese students expressed satisfaction with mobile learning (24). In addition to the popularity of cell phones as a learning tool, learners' self-efficacy in the use of cell phones has been reported as high (24). Lai and Mao (2014) showed the self-efficacy of students in mobile learning is very high. Many of them believed that they were able to use cell phones and could learn with them (25). Literature review confirms mobile learning to be effective; yet, nursing instructors have paid little attention to it. According to Salmani et al. (2015), using this method has a positive impact on the meaningful learning of students (26). Chen (2014) used concept mapping to teach English words to Chinese students on cell phones. They examined its impact on students. The group that had used concept mapping performed better (27).

In another study, the effect of mobile application of nursing skills on knowledge, self-efficacy and nursing students' skills was examined, and the results confirmed the increase in self-efficacy, knowledge and skills of learners (28). According to Lall et al. (2019), due to mobile capability, the interaction between learners and learning materials is provided. However, it is necessary to integrate the training with the mentioned device with the organization and learners, so that they can fully understand the performance of the app or tool (29).

Thus, given the importance of students' creativity in strategic and critical wards, such as the intensive care unit where nurses face a series of decision-making challenges and dilemmas, and on the other hand, the impact of applying the nursing process via concept mapping on student learning using cell phones, and lack of research in this field, the present study aimed to investigate the effect of teaching concept mapping with mobile phones on the creativity of nursing students in critical care internships.

## METHODS

The present study was a pretest-posttest randomized controlled trial. All 68 senior nursing students attending the Nursing School in Khorramabad, Iran, who had enrolled in critical care internship courses in the first semester of the academic year 2016-2017, were selected through the complete enumeration method. The inclusion criterion were willingness to participate in the study, no previous familiarity with concept mapping, having a smart phone, and choosing a critical care nursing course for the first time. The exclusion

criteria were absence in more internship sessions, and being a temporary or permanent transfer student.

Students were divided equally into the experimental ( $n=34$ ) and control groups ( $n=34$ ) stratified block randomization. Within the groups, allocation was done by permuted blocks' randomization using a random number table.

Internship was held for each group for a week in neuro-ICU. Each group (including 8 groups of eight to nine people) spent 6 days of the internship on the neurosurgery ICU under the training of the same instructor. In the first day of training for both intervention and control groups, the pre-test was administered using the research instrument. The instrument consisted of two parts. The first part involved demographic information, including age, gender, marital status, place of residence, and the cumulative grade point average of the students. The second part consisted of Abedi's Creativity Test (1983). The creativity test, which was first designed and psychometrically assessed by Abedi in Iran, included the 4 subscales of fluency (22 items), elaboration (11 items), originality (16 items) and flexibility (11 items). The statements in each subscale were scored by a three-option Likert scale in which 1 indicated low creativity and 3 indicated high creativity. The score of each subscale and the total creativity score were calculated separately. The total score ranged between 60 and 180 for each participant. The closer the total scores to 180, the more creative the individual was. In the subscales, the fluency score ranged between 1 and 22, the elaboration score ranged from 23-33, the originality score could be from 34 to 49, and the flexibility score had a range of 50-60. Abedi et al. assessed the reliability of the creativity test using the test-retest method, in which the reliability coefficient of the subscales of fluency, elaboration, originality, and flexibility were obtained as 85%, 80%, 82%, and 84%, respectively (30). In the present study, the tests were administered to 10 students twice with an interval of 10 days. The intraclass correlation coefficients of the subscales of fluency, elaboration, originality, and flexibility were 0.61, 0.66, 0.66, and 0.65, respectively, indicating the reliability of the test. Abedi et al. evaluated the concurrent, face, and content validities of the test, the results of which suggested the test had acceptable validity (30).

In each group, after conducting the pre-test in the early hours of the internship, in a 2-hour session, learners were taught about the concept map and its drawing steps by pen-paper method by one of the researchers. Then, explanations were provided on how to perform care based on the nursing process with concept map and they were asked to take the process of caring for their patients in a hierarchical and pen-paper method manner. The instructor had a master's degree in medical-surgical nursing with a background in teaching and clinical care in the intensive care unit and was familiar with concept map, it's designing, and providing care based on the nursing process. For each hospitalized patient, two students were selected to take care of the patient in groups (two people) based on the nursing process.

Most learners had a smartphone based on the Android operating system. Simple Mind software is a tool for drawing mind maps, arranging and organizing ideas, writings and activities that help the planning process through tree

representations and other patterns. Using this software, it is possible to change the arrangement of information stored on the page, transfer the subject from one branch to another, and print every section. The graphical interface of the program is very simple and designed away from unnecessary complexities. At the end of the first day internship, Simple Mind software, which has advantages such as small size, easy learning and quick installation, was sent to students and installed on their phone with explanations about the software, components, application and how to draw the concept map. They were asked to work with their peer on how to work with this software before the beginning of the second day.

In the following days, the students prepared their patient care based on the nursing process in the form of a concept map with mobile phone and presented it to the teacher. In the process of caring, according to the nursing process with concept map, students first collected objective and subjective data about their patient based on different systems. Then, the data were categorized. Nursing diagnoses were done by the pre-determined form included a list of Nanda nursing diagnoses based on different body systems along with the definition, its characteristics, expected outcomes and nursing measures for learners. For each nursing diagnosis, interventions were developed and performed. The result was evaluated. Then the learners drew the desired care plan using contract shapes, different colors, and guidelines in the form of a concept map via mobile phone. The maps were constantly reviewed and given feedback by one of the researchers. Again in the last hour of the last day of the internship, the post-test was performed with tools.

Data were analyzed with SPSS version 17 using descriptive statistics (mean, standard deviation, and frequency) and analytical statistics (Fisher's exact test, independent t-test, paired t-test, and multivariate analysis of covariance). Fisher's exact test was used to check the homogeneity of the groups in terms of demographic and educational characteristics, independent t-test was used to compare baseline creativity scores between two groups, and paired t-tests were used to check the within subject variability of creativity scores in each group, separately. An adjustment for baseline scores was performed using multivariate analysis of covariance (MANCOVA) at the significance level of 0.05. The study was carried out at the Lorestan University of Medical Sciences after approval by the Ethics Committee (approval code: LUMS.REC.1395.154).

## RESULTS

Demographic and academic characteristics are shown in Table 1. According to Fisher's exact test and the t-tests, there was no significant difference between the two groups in terms of demographic characteristics ( $p > 0.999$ ). The mean scores of creativity before the intervention were 142.42 and 138.32 in the experimental and control groups, respectively. Based on the results of the independent t-test, there was no significant difference between the two groups ( $p > 0.999$ ). Based on paired t-test, the mean total creativity score and the mean scores on all the subscales decreased in both groups in comparison with the pre-intervention scores, which were not

**Table 1. Comparison of frequency distribution of students' demographic and academic variables in the experimental and control groups**

Groups Variables	Experimental		Control		P-value	
	Frequency	Percentage	Frequency	Percentage		
Gender	Male	16	47.1	15	44.1	>0.999
	Female	18	52.9	19	55.9	
Age (year)	≤24	24	70.6	25	73.5	>0.999
	> 24	10	29.4	9	26.5	
Marital Status	Single	31	91.2	30	88.2	>0.999
	Married	3	8.8	4	11.8	
Residence status	Dormitory	22	64.7	23	76.6	>0.999
	Other	12	35.3	11	32.4	
Average of passed courses	15≥	14	41.2	13	38.2	>0.999
	15<	20	58.8	21	61.8	

**Table 2. The comparison of the scores of total creativity and its dimensions in the control and experimental groups**

Variables	Control group				Experimental group				Between groups p-value
	Pretest	Posttest	Difference	Within group p-value	Pretest	Posttest	Difference	Within group p-value	
Fluency	52.20 ± 4.80	47.55 ± 8.08	-4.64 ± 7.62	0.001	52.88 ± 6.46	51.52 ± 7.57	-1.35 ± 8.99	0.387	0.080
Elaboration	25.09 ± 2.81	22.14 ± 4.67	-2.88 ± 5.64	0.050	25.17 ± 4.39	24.91 ± 4.69	-0.47 ± 4.75	0.747	0.046
Originality	35.82 ± 3.65	33.29 ± 6.11	-2.52 ± 6.60	0.032	37.88 ± 6.12	37.76 ± 6.61	-0.11 ± 6.05	0.910	0.022
Flexibility	25.26 ± 2.32	23.67 ± 3.86	-1.58 ± 4.63	0.054	26.47 ± 4.38	25.55 ± 4.20	-0.91 ± 4.48	0.244	0.143
Total	138.32 ± 9.89	126.68 ± 20.33	-11.65±20.76	0.003	142.41±18.64	139.76±21.37	-2.65±21.27	0.473	0.036

significant for the experimental group ( $P > 0.05$ ), but these decreases were statistically significant in the control group ( $P < 0.05$ ). Based on MANCOVA and after adjustment for baseline scores, the changes in the scores of elaboration ( $p = 0.046$ ), originality ( $p = 0.022$ ), and total creativity ( $p = 0.036$ ) showed a significant difference between the control and experimental groups, but did not show any significant difference between two groups in terms of fluency ( $p = 0.080$ ) and flexibility ( $p = 0.143$ ). The total creativity score and subscale scores of both groups are compared and presented in Table 2.

**DISCUSSION**

As a result of rapid advances in information technology, concept mapping is no longer limited to the pen-and-paper method (31). Nowadays, many software applications are available for concept mapping (32). Over the past two decades, some studies have attempted to design computer-assisted learning assessment systems in conjunction with concept mapping strategies (33). While in many previous studies, the effectiveness of the traditional concept mapping approach has been reported, few studies have been conducted on the efficacy of computer-based concept mapping as compared to the pen-and-paper method. Thus, this study aimed to investigate the effect of teaching concept

mapping using cell phone apps on the creativity of nursing students, the results of which indicated its lack of effectiveness. The total creativity score and the scores of the dimensions of creativity decreased after the intervention in both groups in comparison to the pretest scores. The reduction in the scores of creativity and its dimensions was not statistically significant and remarkable in the experimental group. However, significant reductions were observed in the scores of creativity and its dimensions in the control group in the posttest as compared with the pretest. Studies on the impact of concept mapping on creativity have reported different and sometimes inconsistent results. Some studies have suggested that this method is ineffective, but most studies have confirmed the effectiveness of this method. In a case-control quasi-experimental study, Riley and Ahlberg (2004) investigated the impact of concept mapping using communication technologies on the creativity of 57 students. The results showed that there was no significant difference between the experimental group, which used concept mapping, and the control group in terms of creativity. Thus, this study found no definitive evidence of a relationship between concept mapping and creativity enhancement (34). Additionally, Hosseinzadeh et al. (2011) conducted a study aiming to investigate the relationship between creativity and academic achievement with performance in tests based on

concept mapping, in which 101 students participated. Educational achievement tests were used to assess cognitive outcomes and Abedi's creativity test was used to evaluate creativity. The results showed that concept mapping-based tests positively affected academic achievement, but no significant difference was reported in terms of creativity (35). The results of these studies are in line with the findings of the present study.

However, other studies, whether the pen-and-paper or the electronic types, indicated its effectiveness. In a similar study, in teaching pediatric nursing courses, Salmani et al., designed concept maps on computers and sent them to students via Bluetooth. The results demonstrated the effectiveness of cell phone use and concept mapping in improving student learning (26). Another study also highlighted the importance and impact of mobile learning in combination with concept mapping on learners. Chen et al. (2014) applied the cell phone technology and short message service (SMS) to teach English words to students via concept maps. The results showed that the concept mapping strategy along with SMS has beneficial effects on learning English words (27).

In another study, the effect of two different methods of concept mapping, i.e. cell phone touch technology (the experimental group) compared with traditional pen-and-paper concept mapping (the control group), on perceptions, attention, acceptance, and attitude of students and their learning progress in natural science courses were evaluated. The findings showed that attitude to learning and the degree of acceptance of the use of concept maps in learning had a significant and positive effect on the experimental group compared with the control group (32). Wu et al. (2012) also used a strategy based on concept mapping to improve nursing students' learning and provide immediate feedback to them. According to the findings, the learning system enhanced with concept mapping led to improvements in student learning (33).

Thus, in the literature, different results regarding the effect of concept mapping on creativity can be found. In the present study, no enhancement in creativity was observed in the experimental group. Regardless of the type of software used and method of implementation of technology-based concept mapping, including various methods such as SMS and so on, computer-based concept mapping is given priority over the pen-and-paper method for many reasons, including ease of installation and fast execution. However, possible causes for lack of effect of concept mapping on creativity in this study showed that it was difficult for learners to use the app, no Persian language version of the app was available, and students did not know enough English to use the app.

On the other hand, given the significant reduction in creativity scores in the control group, the obtained results could be attributed to the inefficacy of the research instrument, which consisted of 60 items and did not check for the veracity of learners' responses. It seems that the obtained results were likely affected by the boredom and tiredness caused by trying to answer a large number of items. Moreover, among the limitations of the present study, the low sample size and the use of the app for a short period of time (one week) might have affected the results of this study. Among the limitations of this study, there was a probability that the control and experimental participants would exchange views due to their presence in and commutation to the university dormitories and the teaching hospital. To resolve this issue, the experimental group participants were asked not to give any information to other students during the course of the study. In order to comply with research ethics, the control group received full explanations regarding concept mapping and the app used in the research after the data collection phase of the study was completed.

The development of creative thinking skills as one of the important aims of higher education necessitates the application of approaches that will lead to the development of these skills. Based on the results of the present study, it can be concluded that despite some evidence pointing to the effectiveness of the concept mapping method in the context of e-learning and its potential role in promoting the creativity of learners, as well as, due to the limited number of studies conducted on this issue, it is recommended that future studies investigate more extensively the application of this approach in the teaching of different theoretical and practical courses with larger sample sizes and other creativity assessment instruments.

#### Ethical considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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