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Evaluating the Cognitive Engagement and Pre/Post Assessment Ratings after Blended Teaching of Parasitology skills

تقييم الاندماج المعرفي والاختبارات القبلية و البعدية بعد استخدام التعليم المختلط في تعليم المهارات المعملية لعلم الطفيليات الطبية

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Abstract:

Purpose. This research paper evaluates skills gained by face-to-face only and those gained by blended learning. **Design.** In 2022 during the period from January to February, in the employee development unit, the Microbiology Unit, Mega lab, Cairo, Egypt, a follow-up and intervention study was conducted between an experimental group (20 cadets) and a control group (20 cadets) at a Mega lab for applying parasitology lab skills for four weeks' duration. The training process of the experimental group was based on mixing face-to-face training and online activities and tasks sent by WhatsApp daily. The control group's training was totally face-to-face with no app intervention. Scoping instruments to measure levels of cognitive engagement: the Interactive-Constructive-Active-Passive modes (ICAP scale) and pre/post assessments were used for evaluation. The study used repeated-measures ANOVA to compare the means of the series scores for the four modes of the ICAP scale at the end of every week and the pre/post assessments results concerning the two groups. **Findings**. The detailed quantitative analysis of pre/post assessments confirmed that the method of blended learning facilitates the acquisition of parasitology skills more efficiently ($p<0.001$) where 60% of cadets matched advanced level, 35% became proficient, and only one cadet (5%) had a basic level. The dynamics of the ICAP scale revealed that blended training increase engagement, practical working, and sharing of information and skills enthusiastically whilst face-to-face revealed that cadets didn't achieve the aim. **Originality.** This research paper highlights the possible effective role of social media in supporting coaching on parasitology skills.

Keywords: ICAP scale, pre/post assessments, WhatsApp, face-to-face, engagement, parasitology lab skills.

المستخلص :

غاية هذه الورقة البحثية تقييم المهارات المكتسبة عن طريق المواجهة المباشرة فقط والمهارات المكتسبة من خلال التعلم المدمج. تصميم. في عام 2022 خلال الفترة من يناير إلى فبراير ، في وحدة تطوير الموظفين ، وحدة الأحياء الدقيقة ، معمل ميجا ، القاهرة ، مصر دراسة متابعة ، أجريت دراسة تدخل بين مجموعة تجريبية (20 طالبًا) ومجموعة ضابطة (20 طالبًا) في Mega lab لتطبيق مهارات معمل الطفيليات لمدة أربعة أسابيع. استندت عملية التدريب للمجموعة التجريبية على مزج التدريب وجهًا لوجه والأنشطة والمهام عبر الإنترنت التي يرسلها WhatsApp يوميًا. كان تدريب المجموعة الضابطة وجهاً لوجه تمامًا دون تدخل التطبيق. أدوات تحديد النطاق لقياس المشاركة المعرفية ، تم تقييم الأنماط التفاعلية–البناءة–النشطة–السلبية (مقياس ICAP) والتقييمات السابقة / اللاحقة. استخدمت الدراسة المقاييس المتكررة ANOVA لمقارنة متوسط درجات السلاسل للأنماط الأربعة لمقياس ICAP في نهاية كل نتيجة ضعيفة ونتائج ما قبل التقييمات اللاحقة المتعلقة بالمجموعتين. الموجودات. أكد التحليل الكمي المفصل للتقييمات السابقة / اللاحقة أن طريقة التعلم المدمج تسهل اكتساب مهارات علم الطفيليات بشكل أكثر كفاءة ($P<0.001$) حيث 60٪ من الطلاب يتطابقون مع المستوى المتقدم ، 35٪ أصبحوا بارعين ، وطالب واحد فقط (5٪) كان له مستوى أساسي. كشفت ديناميكيات مقياس ICAP أنه عندما تعرض الطلاب للتدريب المختلط أصبحوا أكثر تفاعلاً وعملوا وتبادلوا المعلومات والمهارات بحماس بينما كشفت المواجهة وجهاً لوجه أن الطلاب العسكريين لم يحققوا الهدف. أصالة. تسلط هذه الورقة البحثية الضوء على الدور الفعال المحتمل لوسائل التواصل الاجتماعي في دعم التدريب على مهارات علم الطفيليات.

الكلمات المفتاحية: مقياسICAP – التقييمات القبلية و البعدية – واتساب – مباشر وجها لوجه – الاندماج.

Introduction

Continuous evaluation and training have become a requirement to sustain the accreditation of the institutes **(Chi and Wylie, 2014)**. Significant resources support the training of medical personnel in labs both face-to-face and online **(Coole et al., 2020)**. In this context, communication is considered a tool of voluntary knowledge sharing and transfer from one subsidiary to another in highly turbulent environments **(Miao et al., 2011, Teng and Song, 2011, Jones and Mahon, 2012, Ghobadi and D'Ambra, 2012)**. However, communication seemed to be subjective **(Simonin, 1999)** and related to the structure of the workspace **(Coradi et al., 2015)** which might hamper the successful transmission of information **(Javidan et al., 2005)**.

Recently, online training despite being a chief tool of knowledge transfer, several courses are solely concerned with the theoretical content and dismiss hands-on; thus, the learning process does not achieve its target **(Bedenlier et al., 2020)**. In this context, the real challenge is to convert online learning into a preeminent way of training and acquiring knowledge by assuming to recall the content and skills efficiently. In 2018, **Ashraf et al.** determined that eye-tracking through recording the visual attraction and interaction is a new form of parasitology education that had been attracting attention; a matter that increased following the pandemic of COVID-19 (**Kołodziej et al., 2021)**.

Another point of the challenge is the lack of engagement to accomplish a training course that may hamper the learning process. This might be attributed to technical issues with operating systems and browsers; therefore, choosing an available mobile application to induce the training process is a masterpiece **(Elzainy et al., 2020)**.

It is advisable to plan before the initiation of the training course to assume competency-based education. Also, the training context should be a two-dimensional model that tangles the technical skills as a horizontal dimension and the non-technical facet as a vertical dimension of the training **(Dall'Alba and Sandberg, 2006).** Specific indicators should be set prior to executing the course and measured quantitatively to evaluate this paradigm. Therefore, constructing and generating assessment tasks in a flexible way to evaluate various levels of engagement and scoring of the learners is mandatory; thus differentiating, and ranking among them can be done **(Gielen et al., 2003).**

Pre/post-testing to meet or surpass a predetermined minimum passing score had been regarded as one indicator of successful and continual medical training **(Clark et al., 2014)**. Pre/post-testing is regarded as a valuable tool for teachers because it demonstrates baseline information about their cadets. Thus, giving these assessments multiple times during training facilitates the monitoring of the progression of a cadet to make any necessary changes.

The interactive-constructive-active-passive (ICAP) scale had been implemented to assess engagement in learning activities. The framework of the ICAP scale links the apparent behavioral actions of the learner to distinct modes of cognitive engagement. Consistently, each mode of cognitive engagement involves diverse levels of knowledge-transformation processes changing from passivity to interactivity; hence an increasing level of significant learning occurs. Passive engagement students encounter listening to a lecture, reading instructions, or watching a video. Learners become actively engaged when they repeat, practice, or copy notes. To be constructively engaged, a learner must convert the original material into reflection, integration, and self-explaining concepts. Interactive engagement symbolizes the deepest level of cognitive engagement through explaining their thoughts to one another **(Chi and Wylie, 2014)**. In addition to the feasibility of the ICAP scale for face-to-face learning, interactive learning can be used as well to measure engagement in online learning environments **(Akcaoglu and Lee, 2016).**

Despite several studies on online learning, we argue that the distant learning hypothesis is still questionable as a theory of learning strategy and that the research in the field of learning laboratory skills didn't meet some of the most remarkable and significant inquiries **(Bird et al., 2022)**. May online learning provoke successful cognitive engagement besides face-to-face learning? May online learning induce progressive improvement in acquiring laboratory skills concerning parasitology?

In this context, the aim of the current study is to scope the addition of online training to face-to-face learning as an instrument to improve cognitive engagement, active learning, and training in parasitology lab skills. Accordingly, two training paradigms were conducted the blended training course (face-to-face + online training) and the face-to-face pursue. Thereafter, cadets were evaluated through pre/post assessments where the results were criterion-referenced and the ICAP scale of cognitive engagement.

Methodology

Study population. This is a follow-up and intervention study that was conducted among recently hired employees with Bachelor's Degrees in Science in the employee development unit, the Microbiology Unit, Mega lab, Cairo, Egypt.

Ethical statement. Approval of the Human resources (HR) unit and the head of the microbiology Department-Mega lab. was taken.

Methods. Forty cadets had a course in parasitology skills as a part of the Technical Skills program integrated into the training set of courses in the Mega lab during the period 2020-2021. Each group of 20 cadets had their course for four consecutive weeks. The main target was to aid cadets to approach constructive learning through discovery and practical application **(Brieger et al., 2020)**; therefore, practical constituted 70% of the current study whereas theoretical knowledge and values constituted the remaining 30%.
For each group of cadets, the same educational material was presented by the same instructors, face–to–face with a total of 40 chemists. Then, one of the groups (intervention group, 20 cadets) was subjected to an additional supplementary online training course using the WhatsApp group. The 20 cadets of the intervention group had participated voluntarily and were those who were going to be hired in the branches distant from the central laboratory unit in Cairo. All cadets were matched for sex, and age (over 20 years old) and have recently accomplished their high school education in Egypt.

To set the training context, a competency-based instructional framework designed by **Czerkawski and Lyman, 2016** was implemented and applied to both groups **(figure 1)**. To monitor the academic baseline level of each cadet, pre-tests were conducted upon entry that was pre-evaluated for reliability and validity. To monitor the cadet's progress and the effectiveness of the current training program, regular post-testing was applied every 7 days for four successive weeks. In addition, the post-test had multiple forms of tests so that each cadet was not given the same test repeatedly. Each correct response corresponded to a score of + 1 wherein the maximum score was +15 for both pre-test and post-test. The time permitted for each test was 30 minutes. Notably, all provided tests were based on the same learning objectives.

Test rating. Pre/post-assessment test ratings for each cadet were tabulated and calculated for the mean, standard deviation, and significant differences obtained. Results were criterion-referenced to a preset criterion expressed in proficiency levels (low, basic, proficient, and advanced) set by test makers **(table 1)**.

Table (1): Pre/post-assessment test ratings, the related proficiency criterion, and interpretation:

Pre/post-assessment	Criterion	Interpretation
≤7	Low	Scoped for improvement and retesting
8-10	Basic	Retained for a makeup test
11-13	Proficient	Can be trusted to examine samples and execute results
14-15	Advanced	Can be a cadet tutor

The training contexts. (a)Face-to-face training. Using simulators to recreate real-life circumstances so that the cadets can practice in a safe and organized environment. They had practical sessions and were given samples to examine under the microscope and showed their findings to the tutor. **(b) Online training.** A WhatsApp group was created and posts were delivered daily to revise one skill lab per day. Knowledge was conducted in the form of didactic teaching datasets regarding the mode of infection and diagnostic stages followed by sharing the related figures that were labeled by the author. In addition, images or mini-videos sent by the cadets for anonymous microscopic structures in wet mount films or hands-on activities performed by the cadets were discussed and interpreted utilizing voice and text messages on the WhatsApp chat group.

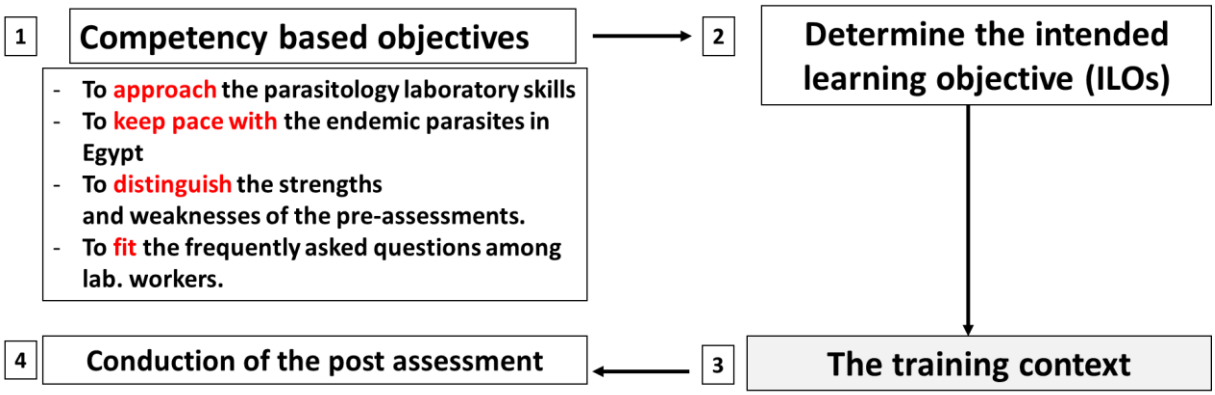

Figure (1): The instructional framework applied to both blended and face-to-face training courses.

Measurement of various modes of cognitive engagement. To generate a questionnaire that evaluates the ICAP scale in parasitology skills a preliminary survey instrument was designed, assessed, and modified to entail appropriate indicators for the engagement dimensions and to ensure its reliability and validity. The ICAP scale analysis used Cronbach's Alpha measure of the internal consistency for the multiple-choice items. We looked for a score of over 7. Continuous quantitative data and responses were gathered and tested every 7 days for each cadet during his/her one-month training course. The resulting survey instrument comprised 24 Likert-type questions. The levels of responses oscillated from agreeing (+3) to disagreeing (+1). In this regard, the result (+16) was the highest score whilst +8 was the lowest for each category on the ICAP scale

Table (2): Frequency of interactive, constructive, and active questions related to training activities within the weekly introduced survey.

Activity	Question type		
	Interactive	Constructive	Active
Guidelines for the acceptance of different biological samples.	**0**	**0**	**1(100%)**
Physical examination of the biological specimens	**1(33.3%)**	**1(33.3%)**	**1(33.3%)**
Wet mount examination of the biological specimens	**2(40%)**	**2(40%)**	**1(20%)**
Concentration by sedimentation of fecal specimens	**1(33.3%)**	**1(33.3%)**	**1(33.3%)**
Staining of intestinal opportunistic protozoa by modified Ziehl–Neelsen stain.	**1(50%)**	**1(50%)**	**0**
Total no. of questions	**5**	**5**	**4**

Overall, out of the 14 positive questions (in the questionnaire supplied in the appendix), 10 questions (71.4%) were interactive/constructive questions across all activities. **Table 2** demonstrates that within the different activities, the percentage of questions implied as "Active" varied, comprising up to 28.5% (4) of the total coded questions.

Outcomes of the study and data management. Data were coded and entered using the statistical package for the Social Sciences (SPSS) version 28 (IBM Corp., Armonk, NY, USA). The primary outcome was the differences between the two groups concerning ratings between pre and post-tests that were criterion-referenced afterward. The secondary outcome was the differences in the potential progression of the items used for the ICAP scale between the two groups of cadets across the four weeks. Data were summarized using mean and standard deviation for comparison of serial measurements. For comparison of serial measurements, repeated-measures ANOVA was used to compare serial measurements, with groups as the between-subject effect and repeated measures as the within-subject effect **(Chan, 2004)**. P-values less than 0.05 were considered statistically significant.

Results

Cadets' Demographics. For the whole study population, 33% and 67% of the recently hired employees were males and females respectively. Cadets' average age was 23, with a range from 21-25 years. Eighty-three percent of the blended cadets (intervention group) used android smartphones and the remaining percent used some other format.

Pre/post-ratings. Using the Repeated-measures ANOVA test the ratings of the pre/post assessments showed significant increases in blended training ($p<0.001$). In contrast, the face-to-face package yielded different results with insignificant changes **(figure 2)**. Referring to the proficiency criterion in table 1, the post-test rating revealed that in the face-to-face training course 12 (60%) cadets were at a basic level (scored 8-10 marks) and 8 (40%) were low (scored ≤7 marks) and remained for a makeup training intervention. In blended training, 12 (60%) cadets matched the advanced level, 7 (35%) were proficient, and only one cadet (5%) had a basic level.

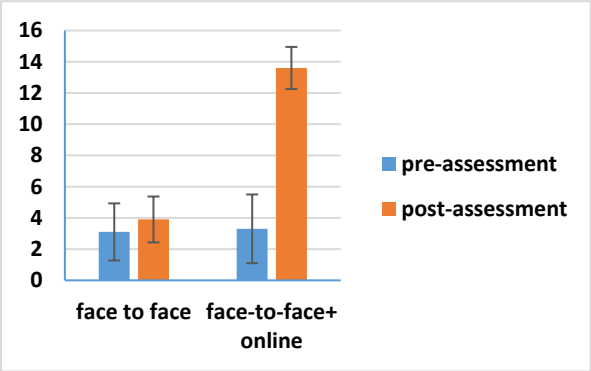

Figure (2): Results of pre/post assessments of the course. (A) face-to-face group, and (B) face-to-face + online group.

The blended learning tool. Manipulation of WhatsApp was convenient for almost 100% of the cadets' smartphones being simple, does not require much internal memory, facilitates the conduction of simple scripts, and does not require a high-speed Internet connection.

Cognitive engagement. In response to the ICAP structure, face-to-face, despite the thoughtful emphasis on interactivity, generated independent messages and minimal interaction between the cadets and the instructor if compared with blended training (p-value < 0.05 using, ANOVA test). **In figure 3, a**, the majority of face-to-face cadets depended on passive ways to gather knowledge in comparison with the blended cadets who were designed to share in the process of knowledge construction. On the same line, in **figures 3 b, c,** and **d**, engagement scores remained to be low in the face-to-face cadets.

On the other hand, the cognitive engagement in the blended training group showed a significant improvement in the scale of ICAP throughout the training course. The passive notetaking was far away from the nature of the instructions given to the cadets who intended to supply the WhatsApp group with images and questions, as represented in **figure 3, a**. The active mode was achieved through active notetaking for the guidelines and steps of the procedure besides applying wet mount examination **(figure 3, b)**. The constructive engagement was achieved by drawing mind maps, producing mini-atlas for parasites by each cadet, and writing notes **(figure 3, c)**. Finally, the level of interactive learning which is the deepest mode of engagement and mirrored the high understanding of knowledge and fostered applicability was achieved through sharing images and videos, peer justification for their errors, and interpreting anonymous structures

uploaded in the WhatsApp group **(figure 3, d)**. Repeated-measures ANOVA test showed that the cadets had significant learning advances from passive to active to constructive to interactive activities compared with a face-to-face training course as revealed by (p-value < 0.05).

As a result, blended training led to the production of a large pool of parasites' images in the WhatsApp group that was interpreted and differentiated from common artifacts. However, the face-to-face training context did not reach this practical skill level.

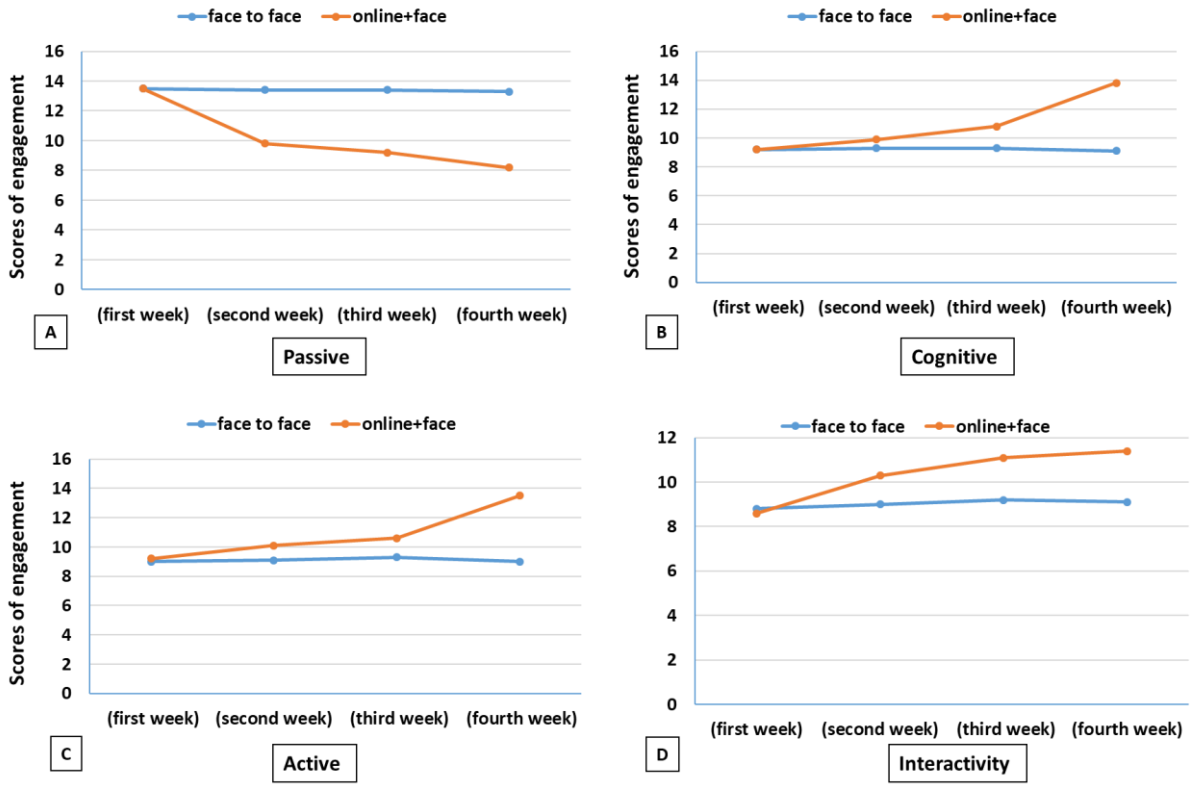

Figure (3): Comparison of the two training packages regarding their improvement through the ICAP scale using the mean values. (a) interactive, (b) constructive, (c) active, (d) passive.

Discussion

In the current study, a structural framework was designed prior to the conduction of the training process. **Maor and Volet (2007)** revealed that the efficient planning, organization, and implementation of online learning courses influence directly the interactivity of the learners. In a prior study, critical thinking appeared to be related to the interactivity of the mentor, and the way the instructor assisted and boosted the discussion. However, the same authors highlighted the importance of establishing a structural framework for the design of the training course either synchronous or asynchronous **(Wagner et al., 2005, Bogdanović, 2012)**; for instance, **Derudas et al. (2021)** exploited the structural system of work that boosted the communication potentials.

In the current study, blended learning generated a significant change in the pre/post-test results if compared with the use of face-to-face learning alone. Similar changes were reported using eye-tracking tools in the virtual learning of microscopic examination in parasitology as shown in the improvements in the education results, professional skills, and lessening errors in parasitological diagnosis **(Kołodziej et al., 2021)**. For researchers in the field of assessment, psychological

perceptions, and engagement influence the outcomes of learning **(Skeff et al., 1992)**.

In general, a skills lab setting permits cadets to make faults and supremely determine and correct them **(Issenberg et al., 2005)**. Accordingly, trainers also need to concentrate on skill development i.e., highlighting "Teachable Moments" **(Weller et al., 2012)**. This was attained in the current study by delivering the skills labs with identical laboratory equipment and photographing their microscopic findings, which allowed the trainers or peers to interpret and discuss their weak points.

In the current study, WhatsApp appeared to have a great contribution to enhancing the teacher-learner relationship beyond class communication. Prior studies deduced that the creation of a community of learners stimulates interactivity and increases the effectiveness of education **(Maor and Volet, 2007, Hershkovitz et al., 2019)**. Interestingly, this can be viewed as a resource investment that maximizes interactivity between time and effort, optimizes experiences, enriches learning outcomes and learner development in particular, and improves the institute's overall performance and reputation **(Trowler, 2010)**.

In the current study, the manipulation of WhatsApp was convenient and facilitated the conduction of a simple script. Another issue, the continuous delivery of information concerning applied parasitology skills between the tutor and the learners was associated with boosted hands-on (the active category in the ICAP scale) and minimized the need to download any programs or print out documents (the passive category in the ICAP scale). **Barlow et al. (2020)** found that learners had a higher and deeper understanding of the educational materials when taught using hands-on activities that promoted interactive engagement.

In the current study, the WhatsApp group from all cadets irrespective of their different working places aided to pool a large volume of images supplied with explanations for the characteristic features of each parasite and short hints regarding the mode of infection and diagnostic stages. Similar to our result, **Stuijfzand et al. (2016)** revealed that the acquisition of knowledge based on eye-tracking and interpretations of anonymous delivered through computers deepen the cognitive load among medical learners. On the other hand, Face-to-face results were disappointing and resulted in low interactivity and image pooling.

In the current study, interactivity-created peer-peer communication. Despite the different situations, a previous study concerning PAL (peer-assisted learning) revealed that skills lab training must not be essentially led by the faculty in order to achieve long-term success and knowledge acquisition and that executing training by peer-trained cadets proved to be as such useful. It is noteworthy that this is correspondent to medical faculty-instructed training **(Weyrich et al., 2009, Hudson and Tonkin, 2008, Tolsgaard et al., 2007)** as it permits "eye-level learning" **(Buss et al., 2012, Yu et al., 2011)**. However, the social and cognitive resemblance between students, tutors, and other cadets can affect PAL **(Ten Cate and Durning, 2007, Lockspeiser et al., 2008)** as they are able to communicate informally due to their similar social roles **(Schmidt and Moust, 1995).** In addition, student tutors and students have similar knowledge bases and learning experiences and speak the same "language" which is commonly termed "cognitive congruence" **(Yu et al., 2011)**. Therefore, students' cognitive, psychomotor and affective progression can occur **(Secomb, 2008)**.

Conclusion

The dynamics of ICAP revealed that cadets who were exposed to blended training have been working vigorously and stayed engaged when they shared information in the WhatsApp group, as the majority of them reached the interactivity level of cognitive engagement in the ICAP cognitive scale. Face-to-face training revealed how cadets did not pursue their goals efficiently. It has been demonstrated that the blended type of training enforced the preparation of well-trained professionals in the field of applied parasitology and increased the educational value of their training. Approaching interactivity in the training program largely shaped an "ideal environment" that was attributable to the trainers' attitude. In this way, the current study introduces a training model to overcome one of the most obvious limitations to improving the professional levels of laboratory workers due to loss of engagement. Hence, supplying the training program with a tool of communication appeared to be an essential complement to a successful training program.

Conflict of interest

The author declares that there was no conflict of interest.

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