# Medical students' evaluation by serious game in the era of Covid-19 infection

## Evaluation des étudiants en médecine par les jeux vidéo pendant l'ère de l'infection par Covid-19

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**Abstract**

**Introduction**: Simulation using serious games (SG) has emerged in the field of training and assessment of medical students.
**Aim**: to compare the results of medical students' evaluation by virtual simulation using online SG and clinical case-based multiple-choice questions (MCQ), and to assess the degree of satisfaction with these two evaluation methods.
**Methods**: Medical students from the same level of study participated in this study. SG group had an evaluation by SG dealing with "diagnosis and management of ST-segment elevation myocardial infarction (STEMI). MCQ group was evaluated by clinical case-based MCQ having the same topic as SG group. Results of the two groups were compared. A satisfaction questionnaire was filled out by the two groups. The satisfaction degree was compared between the two groups.
**Results**: A total of 64 medical students (G1:31 and G2: 33) were enrolled. Thirty learners (96.8%) in SG group obtained a total score ≥ 50% versus 69.7% in clinical case-based MCQ group (p = 0.004). The full score was obtained by three learners in SG group; however, no student scored 100% in clinical case-based MCQ group (p = 0.027). Medical evaluation using SG was reported to be more innovative, fun, and realistic compared to evaluation by clinical case-based MCQ.
**Conclusion**: Simulation by SG could be an innovative and effective method in evaluating medical students.

**Key words**: Medical student, evaluation, simulation

**Résumé**

**Introduction**: La simulation par les jeux vidéo sérieux (JVS) a émergé dans le domaine de la formation et de l'évaluation des étudiants en médecine.
**Objectif**: comparer les résultats de l'évaluation des étudiants en médecine par simulation virtuelle à l'aide de JVS et de questions à choix multiples (QCM) basées sur des cas cliniques, et d'évaluer le degré de satisfaction.
**Méthodes** : Des étudiants en médecine ont participé à cette étude. Le groupe JVS a fait l'objet d'une évaluation par JVS traitant du « diagnostic et de la prise en charge de l'infarctus du myocarde avec sus décalage du segment ST (STEMI). Le groupe QCM a été évalué par QCM basé sur des cas cliniques ayant le même sujet que le groupe SG. Un questionnaire de satisfaction a été rempli par les deux groupes.
**Résultats**: 64 étudiants en médecine (G1 : 31 et G2 : 33) ont été inscrits. Trente apprenants (96,8 %) dans le groupe JVS ont obtenu un score total ≥ 50 % contre 69,7 % dans le groupe QCM (p = 0,004). Le score complet a été obtenu par trois apprenants du groupe SVS ; cependant, aucun étudiant n'a obtenu 100 % dans le groupe QCM (p = 0,027). L'évaluation médicale à l'aide de SG a été signalée comme étant plus innovante, amusante et réaliste par rapport à l'évaluation par QCM.
**Conclusion**: La simulation par JVS pourrait être une méthode innovante et efficace pour évaluer les étudiants en médecine.

**Mots clés**: étudiant en médecine, évaluation, simulation

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# Introduction

Because of Covid-19 infection pandemia, medical education was disturbed [1]. In-hospital training was suspended, creating a delay in education of medical learners as well as difficulty of evaluation [2, 3]. Therefore, several medical inversities worldwide had adopted virtual learning methods. Evaluation of the learner represents a principal step in medical education [4]. This step is based not only on knowledge verification but also on skills and competences evaluation [5,6]. At the end of evaluation, medical learner could acquire new competences, make an auto-evaluation and get certification. Using multiple choice questions (MCQ) remains a reference method for medical students' evaluation [7]. Last years, virtual simulation using serious games (SG) emerges in medical education and in evaluation of medical learner [8]. The aim of this study was to compare results of medical learner evaluated by virtual simulation using SG to those evaluated by case-report- MCQ and to demonstrate satisfaction degree between the two methods of evaluation.

# Methods

## Population study

This is a case-control study conducted during the university year 2020-2021 and including volunteer medical learners (Figure 1). All learners had already succed their cardiology certificate. These students were randomly divided into two groups; the SG group containing students participated to virtual simulation using SG prepared on a website (9). Evaluation questions were integrated in each step of the scenario and learner responded gradually on questions. The second group comprising learners having the same clinical case as the SG group but presented as a clinical case-MCQ. The clinical case-MCQ is sent to learners and sent back to the trainer by emails. Total alloted time for both SG and clinical case-MCQ was fixed at 15 minutes.

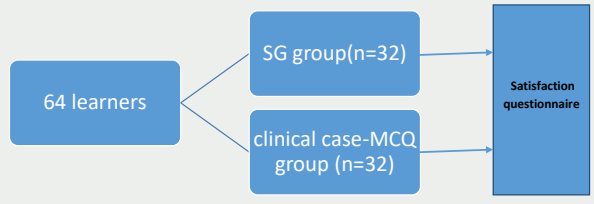


**Figure 1.** population study (flowchart)

## Serious game

SG was available in computer and tablet. It represents patient presented in a three-dimensional (3D) environment consulting emergency room for chest pain and dyspnea (Figure 2).It dealt with the diagnosis and management of ST segment elevation myocardial infarction (STEMI) complicated by acute heart failure. The students played the role of the doctor by questioning the patient, performing a clinical examination (pulmonary auscultation, etc.), interpreting electrocardiogram (ECG) as well as indicating an initial treatment. Because of the Covid-19 pandemic, meeting between trainer and learners was carried out remotely by using "Microsoft Team" program. Trainer shared his screen for each learner apart. All learners had the same SG scenario. A briefing was carried out by trainer before starting SG session. Trainer played also the role of facilitator by manipulating SG according to the responses of learners without intervening in their choices. We used SG already created by trainer from the Mediactiv site (https://www.medicactiv.com/fr/) (9). Contextual MCQ appeared during each step of the scenario. Learner received a precise correction at the end of the game. Results are expressed on a total of 100 points divided into five sub-categories: questioning out of 20, clinical examination out of 20 points, ECG interpretation out of 20, diagnosis out of 20 and therapeutic decision out of 20. Total points are awarded if the student chooses all correct answers and the half of the points was allocated when some answers are correct. There is no penalty for wrong answers.

During the progression of the serious game, learner should complete Knowledge-Based Objective by being able to recognize key signs, symptoms, and diagnostic features of STEMI as well as to interpret electrocardiogram. Skill-Based Objectives were managing the emergency situation of STEMI and selecting the appropriate therapeutic decision.

At the end of SG, trainer presented a short debriefing. Students shared their feedback and opinion about the SG Learners reviewed their performance, identified areas for improvement and applyed learning resources to improve outcomes in subsequent game scenarios and real situations. Trainer thanked all the learners for their commitment and participation.

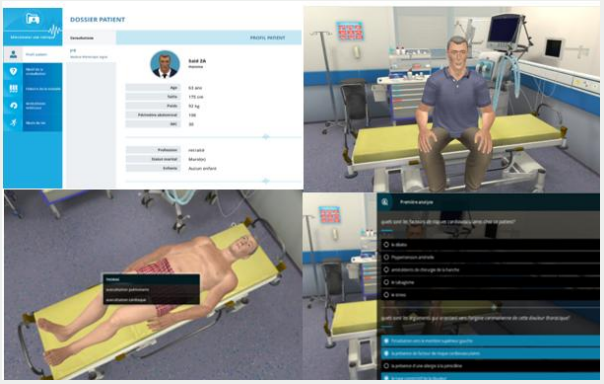

**Figure 2.** Serious game illustration

## Clinical case-MCQ

Online clinical case-MCQ containing the same clinical informations and the same ECG presented by SG was distributed to the second group. Each MCQ includes five possible answers. Answers must be sent within 15 minutes. The correction has been aligned with that of SG with a final note out of 100 points. Learners sent back their answers to trainer who attributed marks. There was no debriefing for this group.

### Satisfaction

A satisfaction questionnaire was filled online immediately after the end of SG and clinical case-MCQ evaluations. Learner must check "yes" or "no" on each satisfaction question (Annex 1).

### Statistical Analysis

Categorical variables are presented as absolute values and proportions. Continuous variables are presented as means ± standard deviations (SD). The Chi-square test was used for comparison of categorical variables between groups, respectively. The Fisher test was used for comparison of categorical variables between groups when the sample size <5. A p value <0.05 was set for statistical significance. Statistical analyses were performed using Statistical Package for Social Sciences (SPSS) version 21 (IBM, Armonk, NY, USA).

## Results

A total of sixty-four students were included in this study. SG group (17 females and 15 males) mean age was 22.09±0.2 years. In this group, seven learners (21.9%) had previously participated in SG. The average age of the clinical case-MCQ group was 22.09±0.3 years with a participation (16 females and 16 males). Ten learners (31.3%) in the clinical case-MCQ group previously participated in SG. Obtaining complete mark in the steps "questioning" and "clinical examination" parts is significantly higher in the SG group compared to the clinical case-MCQ group. There was no significant difference detected between the two groups in terms of interpretation of ECG and diagnosis of STEMI. In the initial management step, more learners of SG group obtained a full score compared to the clinical case-MCQ learners (56.3% vs, 31.3% ; p=0.04). Thirty-one learners (96.9%) in-SG group obtained a total score ≥ 50% versus 68.1% in clinical case-MCQ group (p = 0.02). The full score of 100% was obtained in two learners in SG group while no student scored 100% in clinical case-MCQ group. (Table 1).

**Table 1.** Comparison of the evaluation results between the SG group and the clinical case-based MCQ group.

| Number of learners having complete mark on the following sections : | SG group (n=32) | Clinical case-based MCQ group (n=32) | P |
|---|---|---|---|
| Questioning (n=29) | 20 (62.5%) | 9 (28.1%) | 0.006 |
| Clinical examination (n=26) | 18 (56.3%) | 8 (25%) | 0.01 |
| ECG interpretation (n=37) | 21 (65.6%) | 16 (50%) | 0.20 |
| Final diagnosis (n=31) | 19 (59.4%) | 13 (40.6%) | 0.13 |
| Initial treatments (n=28) | 18 (56.3%) | 10 (31.3%) | 0.04 |
| Total marks of all the sections ≥50% (n=56) | 31 (96.9%) | 25 (78.1%) | 0.02 |
| Total marks of all the sections =100% (n=2) | 2 (6.3%) | 0% | - |

**ECG** : Electrocardiogram, **MCQ** : multiple-choice questions; **SG** : serious game

The global satisfaction is summarized in Table 2. There were significantly more learners who had difficulty answering questions in the clinical case-MCQ group than the SG group (81.3% vs. 43.8%; p=0.002). Compared to the clinical case-MCQ group, twenty-three learners from the SG group declared that SG is realistic (74.2% vs. 48.5%; p=0.03). A significant higher number of the SG group learners reported improvement in their knowledge after the SG assessment compared to clinical case-MCQ (75% vs. 46.9%. p=0.02). However, the learners did not experience a significant difference between the two evaluation modalities in terms of compatibility with medical knowledge and the stress generated by the evaluation. SG was described as a time consuming method in a significantly higher number of the SG group compared to the clinical case-MCQ group (56.3% vs. 31.3 %; p=0.04).

**Table 2.** Comparison of "yes" responses to the satisfaction questionnaire between the SG group and the clinical case-based MCQ group.

| Number of Learners with "yes" responses | SG group (n=32) | clinical case-based MCQ group (n=32) | P |
|---|---|---|---|
| Did you confront any difficulties in answering the questions? (n=40) | 14 (43.8%) | 26 (81.3%) | 0.002 |
| Is this test compatible with your knowledge? (n=37) | 21 (65.6%) | 16 (50%) | 0.2 |
| Did you think this test is realistic(n=39) | 23(74.2%) | 16 (48.5%) | 0.03 |
| Did you find this method innovative? (n=31) | 30 (93.8%) | 1 (3.1%) | $<10^{-4}$ |
| Did you consider that this method represents a good evaluation method?(n=44) | 26 (81.3%) | 18 (56.3%) | 0.03 |
| Did you think that your knowledge has improved after this method?(n=39) | 24 (75%) | 15 (46.9%) | 0.02 |
| Do you accept to participate in other such methods?(n=51) | 23 (71.9%) | 26 (81.3%) | 0.3 |
| Did you find this test stressful?(n=35) | 20 (62.5%) | 15 (46.9%) | 0.21 |
| Did you find this method fun? (n=27) | 25 (78.1%) | 2 (6.3%) | $<10^{-4}$ |
| Did you find this method time-consuming?(n=28) | 18 (56.3%) | 10 (31.3%) | 0.04 |

**SG** : serious game ; **MCQ** : Multiple-choice questions

## Discussion

In this study, we compared evaluation of medical students by using virtual simulation based on online SG clinical case-MCQ. We also compared the degree of satisfaction with these two evaluation methods. We have shown that the learners who participated in the SG were significantly more likely to obtain a mark of 100% in three sections out of five of the questions, were significantly more likely to obtain a total mark ≥50% and significantly more to obtain 100% of all questions compared to the MCQ clinical case group. Regarding satisfaction, the learners who participated in the SG were more likely to express satisfaction in more than half of the questionnaire items.

Recently, new methods of education and evaluation, such as simulation, have emerged in the field of medical studies. Simulation could take several facets, among which the simulation by SG. Several studies have shown that SG simulation leads to improve student performances by stimulating them to mobilize their knowledge during SG, reason and act in adequate manner [10-15]. Our study has just confirmed these results by demonstrating the contribution of SG in medical student evaluation.

MCQ evaluation remains until now the most used method of medical student evaluation [7]. MCQ assess theoretical knowledge through closed questions without evaluation of skills and practical performance, which are best-assessed simulation [11-16]. In addition to the possibility of sharing SG between students and easy access on the tablet or computer at the request of the learner, simulation by SG also allows a self-criticism and a self-judgment of the learner thanks to the automatic correction of the questions immediately after the end of the SG scenario [17]. Different studies, corroborating our results, have reported a more marked satisfaction of learners by simulation than by MCQ [18-20]. SG simulation may improve learner skills so it can be an alternative to education and evaluation [21]. Although SG is more fun and more innovative compared to MCQ, SG creation in 3D mode remains more difficult, more expensive and needs paid access [22-24]. However, using SG is less expensive than other simulation tools such as high-fidelity mannequins [25]. Moreover, the use of SG seems more time-consuming in both creation and participation, which may limit its use [19]. The evaluation itself appears stressful regardless of the used tool, which could explain our results showing that the stressful effect is comparable between the two methods of evaluation.

### Study limits

Our study compares two different methods of evaluating in a relatively small number of medical students. Online evaluation and participation could limit the learner's adherence. In the SG group, facilitator manipulates the program, which could reduce the learner's commitment and enthusiasm. There was no supervision, no correction of MCQ and self-evaluation. Further large studies are needed to demonstrate the role of SG in medical education.

## Conclusion

Simulation by using SG could be an innovative and effective method of medical students' evaluation allowing a better mobilization of knowledge with a better satisfaction degree.

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