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# Perceived benefits and limitations of game-based simulation education by osteopathy students in early clinical training: A preliminary mixed methods study

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## ABSTRACT

**Background:** Game-based simulation education is becoming an integral component in healthcare programs. It is defined as any educational activity implying simulation procedures to recreate clinical scenarios. Previous studies have shown that simulation can improve patient safety by enhancing healthcare providers' competencies. However, few studies have investigated students' perceptions of simulation within osteopathic programs.

**Aim:** This study aimed to measure and compare Year three osteopathy students' perceptions of a game-based simulation versus traditional clinical training.

**Methods:** Year three students at the end of their 12 weeks clinical training were invited to participate in this research project. This included filling out a Likert-based survey and semi-structured interviews. Three clinical training modalities were implemented and evaluated: a demonstration clinic, a video-streamed demonstration clinic, and a game-based simulation, the clinical battle.

**Results:** Sixty-seven Year three osteopathy students completed the surveys, and eight students were interviewed. The clinical battle was significantly felt as the most engaging, most useful to gain feedback, and least stressful of the three training modalities proposed ( $p < 0.05$ ). The clinical battle was also perceived as similar to a demonstration clinic in formulating a diagnosis and for reflective practice ( $p > 0.05$ ). The semi-structured interviews offered deep structured explanatory narratives drawn from thematic analyses. Five themes were identified: engagement, clinical reasoning improvement, stress, ideas for improving clinical training, and reflective practice and self-assessment.

**Conclusion:** The simulation-based training implemented in this study was positively perceived by students for their clinical education. Future research could focus on the effectiveness of game-based simulation versus traditional training on clinical competencies acquisition.

#### Implications for practice

- An innovative game-based simulation clinical training is perceived as a valuable and safe modality for improving clinical skills among Year three osteopathy students.
- Simulation games enhance engagement through entertaining aspects, friendly competition, and teamwork, positively impacting motivation.
- Demonstration clinics are perceived as stressful and limit interaction, while video-streamed clinics face issues with audio/video quality and tutor-student interaction.
- Findings are institution-specific, emphasising the need for broader research involving multiple institutions and diverse simulation/gamification modalities.

#### 1. Introduction

The more engaged students are in their learning experience, the more they are likely to learn [1]. Student engagement is a multidimensional concept that includes behavioural, cognitive, and emotional components [2]. A combination of these components encouraged by faculty practices and tailored to the specific needs and context of the students, can be most effective in fostering active learning and student engagement in medical education [3,4]. Unlike traditional passive learning through lectures, active learning incorporates a variety of tasks including reading, writing, discussing, listening, and reflecting [5]. Studies show that the use of active learning pedagogies increases students' interest in the subject matter, their memory

skills, and their information acquisition [6] but could also lead to improved academic performance for underrepresented minority students, eliminating the performance gap in traditional lecture semesters [7]. In medical education, active learning methodologies can range from basic activities like observation and discussion to more intricate techniques like simulation and experiential learning [8]. A recent review about osteopathic education indicated that learners expressed a strong preference for active learning methods, while also emphasising the value of self-directed study in their educational journey [9]. By fully including learners in the process of education, these approaches hope for better memorization of material, foster a deeper comprehension, and nurture the growth of critical thinking ability [10]. Additionally, emotional engagement, which describes students' feelings towards study content, teachers, and peers, is an important aspect of medical and healthcare student engagement [11]. Positive emotions such as pride, joy, and moderate levels of anxiety are considered motivators for learning [12]. On the contrary, negative emotions can impact students' learning processes and outcomes [13].

Among active learning strategies, reflective practice is of particular interest in medical education that can be used for improving students' learning outcomes after a classroom interaction [14]. Reflective practice allows learners to reflect on their experiences, analyse their actions and behaviours, and identify areas for improvement [15]. The benefits of reflective practice in medical education include increased learning of complex subjects, and deeper understanding of professional values [16] and recognition of how perspectives, goals, and actions influence patient care and clinical decision-making [17]. The reflective practice could positively influence osteopathic clinical reasoning processes in developing professional competence throughout education and professional career [18,19]. Ultimately, the goal of reflective practice is to promote continuous learning and development, and to ensure that individuals are able to make the most of their experiences [20].

Among active learning approaches, the integration of simulation and gamification has shown promise in enhancing clinical reasoning skills in medical and nursing education, offering engaging and effective learning opportunities [21-24].

Simulation-based education has been integral to healthcare programmes for years [25]. It is defined as any educational activity that involves simulation procedures to recreate clinical scenarios [26]. Simulation-based medical education has also improved patient safety and benefited patient outcomes [27]. Programming courses based on simulated environments makes it possible to create guided sequences tailored to precise learning objectives and needs [28]. It is, therefore, possible to program sequences that review specific clinical reasoning educational objectives related to musculoskeletal pain. Simulation-based educational methods allow students to learn in a controlled environment where they can make, evaluate, and address errors without fear of adverse consequences [26]. Some research has explored the benefits of simulated environments for osteopathic clinical education [29,30], particularly regarding student competence gained through simulation learning versus traditional placements.

Serious games are educational tools used in medical education to promote active and problem-solving learning [31,32]. Serious games offer various modalities in education to enhance learning outcomes and engagement, such as simulation, interactive stories, puzzles, role-playing games, educational computer games, and virtual reality modes [33]. Serious games have been shown to increase medical students' motivation, flow and engagement [34]. Other benefits of serious games in medical education include opportunities for learners to actively learn and solve clinical problems [17], improving knowledge levels and changing behaviour to influence health outcomes [35]. In addition, games have a feedback mechanism and can be designed with a range of difficulty levels, allowing for trial and error without fatal consequences [36]. According to socio-constructivist learning theories, learning and motivation to learn are enhanced by group exchanges and interactions with peers [19], i.e., team members and other players in a serious game. Gamification has recently been used in osteopathic education as a teaching method for revision before final examinations [37,38].

In France, the curriculum in osteopathy is defined by a decree of the French Ministry of Health [39] with 4860 h of training, including 1500 h of clinical practice (50 h in Year 1, 70 in Year 2, 210 in Year 3, 450 in Year 4 and 720 in Year 5). The clinical training programme combines classroom teaching with clinical placements in the Institute's own clinic and in partner training institutions. The programme is divided into three stages: Years 1 and 2 correspond to observation and discovery of osteopathy with professionals in private practice; Years 3 and 4 include progressive learning of the different steps of consultation; and Year 5 involves self-management of a minimum of 150 full consultations.

It is hypothesised that the use of these innovative methods will enhance overall student engagement, leading to improved learning outcomes such as enhanced clinical reasoning abilities. The incorporation of gamification elements is expected to foster a deeper commitment to the educational process. Additionally, simulation-based education is anticipated to contribute to similar perceived levels of competence than traditional clinical training while providing a controlled environment for practice and error correction.

This preliminary study aimed to explore and compare students' perceptions of classic clinical training versus simulation-based training and to explore Year three osteopathy students' perceptions of the benefits and limitations of these educational modalities.

## 2. Materials et methods

### 2.1. Study design

An explanatory sequential mixed methods design was used to understand students' perceptions in this study.

### 2.2. Participants and setting

Year three osteopathy students in the Institut d'Ostéopathie de Rennes-Bretagne (IO-RB), a French Osteopathic Educational Institution (OEI) (n = 68) were invited to participate in a questionnaire-based survey and semi-structured interviews at the end of a 12-week clinical course (between September and December 2020).

Each student received these three training modalities during the same amount of time: demonstration clinic, video-streamed demonstration clinic, and a game-based simulation named the clinical battle.

Each training modality was 32 h long (96 h in total of clinical training), delivered 8 h per week. Each clinical educational activity involved 22-24 Year three students and a clinical tutor.

The three clinical training modalities were guided by a team of six different tutors (not all operating at the same time) having more than five years of clinical experience as osteopaths (mean  $\pm$  SD = 7 years  $\pm$  2).

During the same period, all included students also had 20 h of additional clinical training by observing Year 4 and Year 5 students conducting consultations in the student-led clinic of the institute as part of their regular training. The students were informed of the present study during the last clinical course of the period.

### 2.3. Data collection procedure

Questionnaires were emailed with a link to participate and respond online on a form platform (Framaforms - <https://framaforms.org/>) compliant with the General Data Protection Regulation.

Neither researchers nor teachers were present in the classroom, so that students could decide for themselves whether to answer the survey or not. Students interested in participating in the interviews were asked to contact the researcher by email. All interviews took place two weeks after the 12-week clinical course.

### 2.4. Data collection instrument

Part one consisted of a survey questionnaire with a five-point Likert-type scale. The questionnaire was developed in three stages: 1/a literature search was conducted about factors influencing learning (like engagement, motivation, stress); 2/six Year four and four Year five students who took the same mixed clinical training in the previous years (demonstration clinic, video-streamed demonstration clinic and clinical battle) provided feedback on their past perceived values of the different clinical modalities in a meeting at the OEI; 3/four senior clinical tutors met to organise a workshop and brainstorming. After compiling, analysing and synthesising data during this preliminary phase of questionnaire construction, six themes

emerged: engagement, feedback, stress, diagnosis, osteopathic care, and self-assessment. These themes resulted from triangulating educators' and students' views about important topics to consider along with the literature on factors affecting clinical training education. This questionnaire was pilot-tested on six Year four students to ensure all the questions were understandable. No major changes were made.

In the final survey tool, for each question, students were asked to indicate on a scale ranging from 1 to 5 whether they "strongly disagree" (1), "disagree" (2), (are) "neutral" (3), "agree" (4), or "strongly agree" (5) to each question. The questionnaire consisted of 14 questions organised in 6 themes related to the perceived students' engagement (questions 1, 2, and 3), capacity to gain feedback (questions 4 and 5), stress level (question 7), ability to elaborate a diagnosis (questions 8, 9, and 10), learning about osteopathic management plan (questions 6, 11, and 12), and reflective practice (questions 13 et 14) with the three clinical training settings (see Table 1). Thus, each question ( $n = 14$ ) was presented for every educational modality ( $n = 3$ ).

Part two consisted of semi-structured interviews. Eight students (four males and four females) were interviewed guided by a set of seven questions that were an extension of the questionnaire. The same person conducted all the face-to-face interviews and recorded them with a voice recorder. The interviews were 10-20 min in duration (mean = 13 min).

## 2.5. Educational interventions

Demonstration clinic consists of peer observation by Year three students of osteopathic sessions performed by a final-year student or an educator. At it, final-year students or educators are encouraged to use a think-aloud approach to explain their clinical reasoning. Debriefings are conducted to bring out at specific points of the consultation without the patient's presence.

Video streamed demonstration clinic consists of the live transmission in the classroom of a consultation in the OEI clinic delivered by a final-year student. This educational approach offers an opportunity to interact directly between students and tutors on the consultation's progress. At the end of the session, the practising student joins the classroom for debriefing.

Clinical battle is a game-based simulation taking inspiration in hip-hop culture. A battle is a competition between individual or teams of rappers or dancers who exchange their best performance; a jury or the public judges the outcome [40]. In clinical battle, students are distributed into four teams of five or six players [41]. A match opposes two teams and involves two phases where each team is in turn 'practitioner' and 'patient'. Students have 2 h to prepare simulated scripts for their 'patient' turn: they review the medical history questions and then create and rehearse the simulated cases (two cases per team are covered in 2 h). Battles take place over the following 2 h. To do this, each team nominates one practitioner and one patient. The goal of the "practitioner" team is to accurately triage the biomedical condition simulated by the "patient" team (e.g. cauda equina syndrome, axial spondyloarthritis, multiple sclerosis, etc.). To remain in the competition, each team has to accurately triage the patient (i.e., is the

patient appropriate for osteopathic treatment or should the patient be referred?) with a rationale for their decision. Then after the two rounds when each team was in turn 'patient' and 'practitioner', students debated with each other to decide on the winning team based on which team is closer to the simulated diagnoses. An educator moderates the clinical debate and encourages exchanges while providing opinions or experiences relating to the presented cases.

## 2.6. Data analysis

Quantitative data were analysed using the Jamovi statistical package for macOS (Jamovi version 1.6). Descriptive statistics (means and standard deviation) were generated for each of the three clinical training approaches and each questionnaire item. Normality of distribution was assessed with the Shapiro-Wilk test.

Friedman One-Way Repeated Measure Analysis of Variance by Ranks was performed to evaluate differences between the means of the three groups and each of the 14 questions. Scores were then compared with post hoc pairwise comparisons. The internal consistency of the whole questionnaire was evaluated by using Cronbach's alpha showing high internal consistency and reliability ( $\alpha = 0.92$ ).

Semi-structured interviews were recorded on a phone device (iPhone Xr and its built-in audio recorder) and then transcribed on a spreadsheet. The verbatim report was produced in French (only the subsequent results were translated into English). The interview transcriptions and the open-answer survey questions were analysed independently by two persons using a deductive approach. Existing questions made for the Likert-type questionnaire served as a basis to deepen the understanding of the students' responses to the survey. Line-by-line coding and a matrix were employed to realise content analysis following established methodologies [42].

## 2.7. Ethics

This study was approved by the IO-RB scientific board. This research was conducted in such a way that the dignity and autonomy of the research participants (students from the IO-RB) were respected and that the research did not cause any significant risks, damage or harm (whether physical or mental) to the research participants. Participation in the research followed the principle of informed consent. Participation was voluntary, and the participants were given sufficient and accurate information about the research. All questionnaires were anonymous. Students who agreed to participate in the study completed a consent form that was included in the online questionnaire. A separate consent form was obtained for students who participated in interviews. Participants were informed in the consent form that they could retrieve their data from the research study for any reason. The first page of the online survey contained a participant information letter. This letter explained the setting, the purpose of the study, the time it should take to complete the survey, the guaranteed anonymity of the obtained data, and that there were no risks or compensation involved with participation in this study to the participants. Participants were required to tick a box at the bottom of the page indicating that they had read the prior statements and so accepted to participate in the study. No personal

data was acquired during the study, and no question could link any participant to the responses they made. Finally, all collected data was secured on the researcher's personal computer and mobile phone, and were fingerprint- and password-protected.

### 3. Results

#### 3.1. Quantitative survey

67 of the 68 Year three osteopathy students answered the survey. Participants had an average age of  $22 \pm 2$  years and 73% were female ( $n = 49$ ). The results of the quantitative survey are reported for each question and for the three clinical modalities in Table 1.

Significative differences were found between the three clinical modalities for all the 14 questions of the survey except for question 5 ( $p = 0.052$ ): "This clinical training setting enhances the interest of debriefing with the tutor".

The clinical battle achieved better scores for questions 1, 2, 4, 6, 7, 8, and 9 (7/14 questions). The demonstration clinic, for its part, performed higher scores for questions 3, 10, 11, 12, 13, and 14 (6/14 questions). Finally, the video-streamed demonstration clinic did not report better scores than the two other clinical modalities for any of the 14 questions.

All the details of each question, with consideration of the clinical modalities, are reported in Table 1.

Table 1

| Questions                                                                                                     | DC                              | VDC                             | CB                              | p-value |
|---------------------------------------------------------------------------------------------------------------|---------------------------------|---------------------------------|---------------------------------|---------|
| 1 In this clinical training setting, I feel invested when I am a practitioner.                                | <b><math>3.9 \pm 0.9</math></b> | <b><math>3.6 \pm 1.0</math></b> | $4.1 \pm 1.2$                   | <0.01   |
| 2 In this clinical training setting, I feel invested when I am observer.                                      | $3.1 \pm 1.0$                   | $2.3 \pm 1.2$                   | $4.0 \pm 1.1$                   | <0.01   |
| 3 My engagement in this clinical training setting depends on the tutor.                                       | <b><math>4.2 \pm 1.0</math></b> | $3.7 \pm 1.3$                   | <b><math>4.1 \pm 1.2</math></b> | <0.01   |
| 4 This clinical training setting promotes the interest of debriefing between students.                        | <b><math>3.8 \pm 1.1</math></b> | <b><math>3.6 \pm 1.3</math></b> | $4.4 \pm 1.0$                   | <0.01   |
| 5 This clinical training setting enhances the interest of debriefing with the tutor                           | $3.9 \pm 1.0$                   | $3.7 \pm 1.2$                   | $4.1 \pm 1.2$                   | 0,052   |
| 6 This clinical training setting allows me to work on the therapeutic relationship                            | <b><math>2.8 \pm 1.1</math></b> | $2.4 \pm 1.2$                   | <b><math>3.1 \pm 1.4</math></b> | <0.01   |
| 7 This clinical training setting is stressful in the case where I am a practitioner.                          | $4.6 \pm 0.7$                   | $3.4 \pm 1.3$                   | $3 \pm 1.3$                     | <0.01   |
| 8 This clinical training setting allows me to improve on the anamnesis.                                       | <b><math>3.9 \pm 1.0</math></b> | $3.1 \pm 1.3$                   | <b><math>4.1 \pm 0.9</math></b> | <0.01   |
| 9 This clinical training setting allows me to improve on serious condition diagnosis.                         | <b><math>3.4 \pm 0.9</math></b> | <b><math>3.1 \pm 1.1</math></b> | $4.2 \pm 1.0$                   | <0.01   |
| 10 This clinical training setting allows me to improve on the treatment plan.                                 | $4.0 \pm 0.9$                   | $3.3 \pm 1.2$                   | $3.0 \pm 1.2$                   | <0.01   |
| 11 This clinical training setting reminds me of techniques and helps me to improve on my future treatments    | $4.0 \pm 0.9$                   | $3.0 \pm 1.2$                   | $2.3 \pm 1.2$                   | <0.01   |
| 12 This clinical training setting allows me to improve my advice to future patients.                          | $3.7 \pm 1.2$                   | $3.4 \pm 1.4$                   | $2.7 \pm 1.3$                   | <0.01   |
| 13 In this clinical training setting I can self-evaluate my own gaps in terms of osteopathic care             | <b><math>3.7 \pm 1.0</math></b> | $3.1 \pm 1.3$                   | <b><math>3.5 \pm 1.3</math></b> | <0.01   |
| 14 This clinical training setting allows me to make progress on my gaps and find action plans to remedy them. | <b><math>3.6 \pm 0.9</math></b> | $3.0 \pm 1.1$                   | <b><math>3.5 \pm 1.1</math></b> | <0.01   |

Table 2 reports the mean scores regrouping questions into six themes. Scores were significantly different regarding the three clinical training modalities ( $p < 0.01$ ). Students perceived the clinical battle as the most engaging ( $4.1 \pm 1.2$ ), the most useful to gain feedback ( $4.2 \pm 1.1$ ) and the less stressful ( $3.0 \pm 1.3$ ) clinical training modality of the three proposed.

Table 2

|   | Themes              | DC               | VDC              | CB               | p-value |
|---|---------------------|------------------|------------------|------------------|---------|
| 1 | Engagement          | 3.7 ± 1.1        | 3.2 ± 1.3        | 4.1 ± 1.2        | <0.01   |
| 2 | Feedback            | <b>3.9 ± 1.1</b> | <b>3.7 ± 1.2</b> | 4.2 ± 1.1        | <0.01   |
| 3 | Stress              | 4.6 ± 0.7        | 3.4 ± 1.3        | 3.0 ± 1.3        | <0.01   |
| 4 | Diagnosis           | <b>3.8 ± 1.0</b> | 3.2 ± 1.2        | <b>3.8 ± 1.2</b> | <0.01   |
| 5 | Management          | 3.5 ± 1.2        | <b>2.9 ± 1.3</b> | <b>2.7 ± 1.3</b> | <0.01   |
| 6 | Reflective practice | <b>3.6 ± 1.0</b> | 3.1 ± 1.2        | <b>3.5 ± 1.2</b> | <0.01   |

DC = Demonstration Clinic; VSDC = Video-Streamed Demonstration Clinic; CB = Clinical Battle.

The clinical battle was perceived as similar (not significantly different) to the demonstration clinic for the elaboration of a diagnosis ( $3.8 \pm 1.0$  vs  $3.8 \pm 1.2$ ) and for reflective practice ( $3.6 \pm 1.0$  vs  $3.5 \pm 1.2$ ).

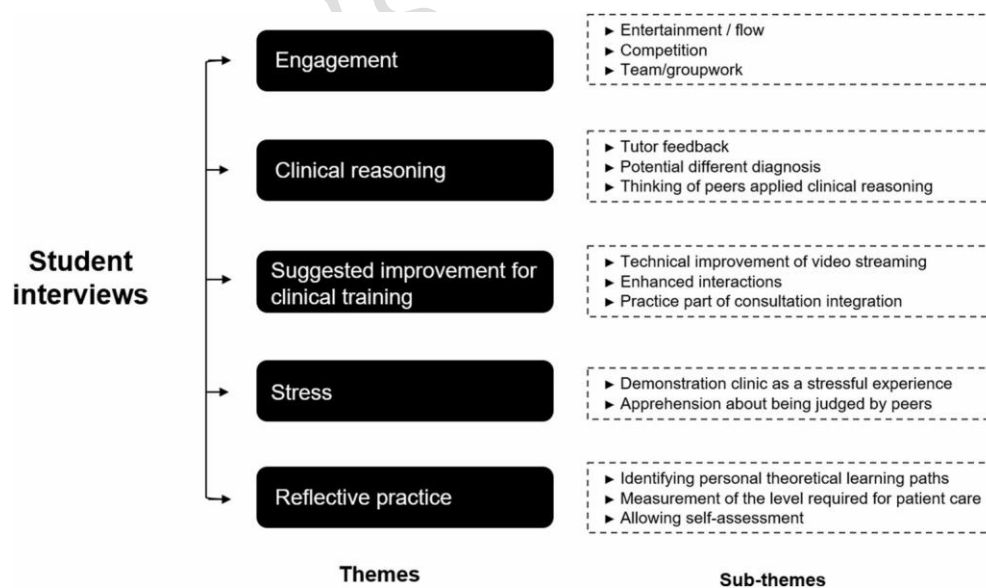
In addition, the demonstration clinic was the most stressful clinical training modality as perceived by students ( $4.6 \pm 0.7$ ). It was also seen as the most effective modality for learning osteopathic management of a consultation ( $3.5 \pm 1.2$ ).

### 3.2. Semi-structured interviews

This qualitative part of the study collected rich data on students' perceptions and opinions about the value of the three clinical training modalities.

Five main categories were built from the content analysis: "engagement", "clinical reasoning improvement", "suggested improvement for clinical training", "stress", and "reflective practice" as reported in Fig. 1.

Fig. 1. Identified themes and subthemes from student interviews.



#### 3.2.1. Engagement

According to the interviews, four students felt more involved in clinical battle compared to three students in the demonstration clinic and one in the video-streamed demonstration clinic. The

involvement of students in clinical battle was explained by the entertainment of the simulation-based environment, the spirit of competition as a game and group motivation and involvement in the clinical reasoning of this clinical training modality:

"Clinical battle was entertaining, we reviewed medical pathology without thinking a minute that we were working", "(it also) gave us the opportunity to participate as a group" P3

"I liked the competitive spirit that the clinical battle brought to the class. I really wanted to show my skills as a practitioner when I was participating in" P4

"I really liked studying with the clinical battle because we worked as a group and it was very entertaining elaborating scenarios of simulated patients with my colleagues" P5

### 3.2.2. Clinical reasoning improvement

In terms of history-taking, opinions were divided between the clinical battle and the demonstration clinic. The fact that there are no real patients in the clinical battle seemed to allow students to improve their history without fear of making a potentially harmful diagnosis. It appeared to improve immediate feedback from the tutor. Furthermore, the competitive aspect involving the decision between "I treat the patient" or "I refer the patient" at the conclusion of the case history prompts the practitioner to thoroughly explore the patient's history:

"The tutor did not hesitate to say what was wrong with the history and that he cannot do in front of a real patient" P3

"We looked far and wide for all possible differential diagnoses because we didn't want to miss a diagnosis and lose ..." P8

Students unanimously feel they improve their search for red flags in clinical battle:

"Cases were complicated and made us think hard about all the possibilities" P1

"In demonstration clinic, there are not many patients who need to be reoriented because of a serious pathology, so in clinical battle it is good to work on them to prepare for such a situation. We also learned a lot by watching other teams participate and propose diagnoses." P2

### 3.2.3. Suggested improvements for clinical practice

For the video-streamed demonstration clinic, proper video/audio equipment might be required to obtain optimal results. Feedback from tutors toward student observers seems to be requested in both demonstration clinic and video-streamed demonstration clinic. Students mentioned the lack of clinical examination during the clinical battle which could improve this format:

"The video equipment should be improved, such as a camera with a wider angle" P2

"We would like to see more input from the tutor during the video-streamed demonstration clinic, to take advantage of the fact that the patient is not in the room to comment on what the practitioner is doing" P4

"It would be interesting to add more interaction with the students, even though this may be inconvenient for the patient, as it would allow more understanding for the observing students" P8

"It would be so interesting to integrate practice during the clinical battle to continue to train each other as a team and not stop at just the anamnesis" P8

#### 3.2.4. Stress

Unanimously, students found demonstration clinic more stressful than other formats:

"It is stressful to be observed by our class. You feel judged" P1

"It's too stressful, I think it's not a good way to start our first clinics with patients" P3

"It's instructive but it's not easy to be confronted with the judgement of twenty or so people, especially if you don't have any self-confidence" P7

Participants found the video-streamed demonstration clinic format to be much less stressful than the demonstration clinic format when managing a patient, particularly as the practitioner soon forgets that he or she is being filmed and transmitted back to the classroom:

"The camera is forgotten as soon as the first words are exchanged with the patient" P6

"Video is less stressful, especially because you are alone with the patient in a consultation room. It is a good training opportunity for the practitioner but not for the observers" P8

### 3.2.5. Reflective practice and self-assessment

The lecture clinics were not perceived to be teaching formats that were conducive to reflective practice and self-assessment. According to the students' remarks, the clinical battle was the best format for self-assessment, especially on the theoretical side. By reflecting on a case-by-case basis, students realised where their gaps were in relation to their peers and to the practitioner's requirements. In general, it seemed difficult for students to assess themselves only by watching other students practise.

"We just realise sometimes that we don't have the same level" P1

"It shows us that we still have things to acquire" P4

"We realise that we are not always up to standard in clinical battle" P6

"The battles allow us to evaluate ourselves on theoretical knowledge, we see where our gaps are and what we need to revise", "as long as we don't practise we can't know where our gaps are, nor have any feedback from the tutor on how we are doing" P3

## 4. Discussion

### 4.1. Summary of findings and comparison to known literature

This preliminary study explored the perceived benefits and the limitations of three educational modalities (demonstration clinic, video-streamed demonstration clinic and clinical battle) experienced by Year three osteopathy students in clinical training. The main findings of this study showed that clinical battle was perceived as a relevant modality for improving clinical history-taking and triage skills prior to clinical encounter with patients. This simulation-based environment was perceived to be as effective ( $p > 0.05$ ) as observing a real consultation for elaborating a diagnosis and reflective practice. Clinical battle was seen as a safe environment to practise looking for red flags and formulating a diagnosis without the fear of making a potentially harmful diagnosis. It was also suggested that interaction with the tutor and feedback was more frequent. The demonstration clinic was seen as highly instructive for the management part of an osteopathic consultation but was also considered the most stressful, probably relating to the fear of being judged by one's peers. The video-streamed demonstration clinic only showed a better score for stress than the demonstration clinic.

Data obtained from the qualitative analysis were triangulated with the survey results.

Participants' comments about the enhanced engagement with a simulation game-based environment could be categorised into three types. First, there were comments about the entertaining aspect of the simulation environment. This serious game gave the students the feeling that they were not actually studying, even though they had had 2 h of preparatory training on red flags for this sequence. The experience of flow and emotional engagement in a gamified learning environment has a crucial impact on students' motivation [43]. Secondly, participants reported another characteristic of a serious game which is the competition that occurs during the clinical battle [44]. The use of friendly competition may motivate students and help them to improve their performance [45]. Third, comments were made about the teamwork aspect of the game, which was appreciated. Indeed, there are few clinical training opportunities that allow the development of clinical reasoning in groups during curricula. This teamwork context might empower students to increase their engagement in peer learning and lower the threshold for interaction with supervisors [46].

The demonstration clinic was seen as less engaging. Students suggested more interaction during the consultation. They are indeed passive observers during this teaching modality and cannot interact directly with the patient or practitioner to avoid disrupting the ongoing consultation. The perceived interest in this modality compared to the others corresponds to the operative aspects of a consultation: developing a treatment plan, applying osteopathic techniques and providing patients health advice (items 10, 11 and 12 of the questionnaire).

The video-streamed demonstration clinic sequences were considered as the least engaging of all. The interviews revealed that the audio and video quality did not allow for optimal follow-up of the consultations. Furthermore, the potential for interaction between the clinical tutor and observing students during such sequences was not perceived as optimally exploited.

Emotional material tends to be better remembered than neutral or emotionless material [47]. Clinical tutors can add an emotional component (mainly positive) while students are learning new information to enhance later recall, for example, by explicit positive verbal reinforcement during classroom learnings. The spirit of friendly competition during the clinical battle could thus foster this type of acquisition. Clinical training requires students not only to recall theoretical study material but also to integrate new knowledge into existing clinical reasoning understanding structures. However, stress may interfere with this process of memory updating [48]. In addition, stress alters the nature or quality of memories. Under stress, more rigid stimulus-response relationships are remembered rather than complex representations of our environment [49] such as complex clinical scenarios. Thus, emotions or mild forms of stress (such as cognitive demands or moderate emotional arousal that results from a gamified simulated educational environment) can enhance memory building, which can have beneficial effects on memory for new material [50]. Furthermore, active participation in stressful situations could facilitate the cultivation of coping mechanisms and enhance proficiency in stress management. However, these effects are likely to follow an inverted U-shape and may be reversed with increased stress levels [51]. This stress factor should be taken into account, particularly for the demonstration clinic, which has been identified as the most stressful form of

clinical education and can lead to a demotivating first clinical experience. Video-streamed demonstration clinics could in this case be a less stressful alternative in this case, while observing a real (non-simulated) consultation.

#### 4.2. Study limitations and perspectives

This study was conducted in one institution, which reduces generalizability to other settings. Further research would be needed on a larger scale involving multiple OEIs and possibly other simulation/gamification modalities to be tested. Future plans include bringing together students from different institutes and countries to participate in these clinical battles in the form of friendly competitions. These meetings will allow us to evaluate this simulated modality of training musculoskeletal red flags in other osteopathic educational contexts.

In addition, we chose to focus on student perceptions, so no objective measures were used to determine if student perceptions were consistent with an increase in student acquisition/learning and if this retention of information could potentially be long-lasting. Further studies would also benefit from including didactic or pedagogical experts in the design process. The characteristics of the participating educators would also benefit from being recorded. This is likely to be considered for future research. This would require, for example, quasi-experimental studies comparing clinical battle with traditional teaching methods. However, it is not yet clear which mix of the different clinical modalities is the best for teaching. The overall outcome result of the sum of the educational strategies may be different from each one in isolation.

Students gave a low rating to the video-streamed demonstration clinic, and it appeared to lack relevance for any of the aspects evaluated, except for being perceived as less stressful compared to the demonstration clinic. A possible development could also be to broadcast a simulated interaction between two students (a clinical battle) to the rest of the class. Students in the room could then discuss, interact or respond to questions posed by the educator in a way that further increases learner engagement.

Possible limitations in the discussion section of the study include concerns about construct validity, where ambiguity in respondent interpretation may affect the accurate measurement of variables. Content validity issues may arise if the survey is not comprehensive and aligned with the study objectives, which may affect the representativeness of the data. Face validity can be a limitation if it is not consistent with participants' perceptions. The study also recognises potential concerns about criterion-related validity, sampling bias and the impact of response and social desirability bias on reliability. Cultural sensitivity, temporal validity and inherent limitations of the survey instrument also contribute to the potential limitations discussed. The next step will be the evaluation of the quantitative questionnaire as a valid measurement tool. Addressing these limitations is essential to enhance the robustness of the study and to guide future research.

## 5. Conclusion

Osteopathic education needs to evolve using the new teaching modalities currently available to stimulate learning and discussion between students and educators about clinical reasoning in an engaging and non-stressful team-based environment. Offering a course in the form of a clinical battle could meet these objectives. The clinical battle creates a playful atmosphere around education and provides an opportunity to stimulate the learning of clinical skills. Not only does this educational modality alleviate the stress and apprehension commonly associated with traditional methods while being perceived as equally efficient for improving triage skills and history taking, but it also establishes a conducive learning environment, promoting interaction not only among students but also between educators and students.

To comprehensively explore the viability and efficacy of these teaching modalities, further research is imperative. Investigating the potential implementation of these approaches in a broader student cohort, irrespective of their year of clinical training, could provide valuable insights into the scalability and universal applicability of such innovative educational strategies.

Furthermore, investigating the adaptability of the clinical battle format to various parts of the osteopathic curricula and diverse clinical scenarios may enhance the versatility of this approach. Understanding how this playful yet rigorous approach aligns with different aspects of osteopathic practice could provide guidance on tailoring the educational experience to specific professional skills goals.

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### Ethical approval

This study was approved by the Institut d'Osteopathie de Rennes-Bretagne's scientific board.

### CRediT authorship contribution statement

Hakim Mhadhbi: Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization.

Lluís M. Horta: Writing – review & editing, Writing – original draft.

Julian Ims: Writing – review & editing, Writing – original draft.

Jerry Draper-Rodi: Writing – review & editing.

Hazel Mansfield: Writing – review & editing.

Robert Shaw: Writing – review & editing.

Sandra Rinne: Writing – review & editing.

Tricia Cleland Silva: Writing – review & editing, Supervision, Conceptualization.

Eija Metsälä: Writing – review & editing, Supervision, Conceptualization.

Mathieu Ménard: Writing – original draft, Validation, Supervision, Methodology, Formal analysis, Data curation.

#### Declaration of competing interest

The authors declare the following interests/personal relationships which may be considered as potential competing interests:

At the time of writing, HMh was a staff member at IO-RB, and no funding was received for this work.

JDR reports a competing interest because he is on the editorial board of the International Journal of Osteopathic Medicine. However, he had no role in the review or decision-making process associated with this manuscript.

MM and RS report a competing interest because they are on the international advisory board of the International Journal of Osteopathic Medicine. However, they have no role in the review or decision-making process associated with this manuscript.

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Appendix A. Supplementary data

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Author's accepted version