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# Artificial intelligence-driven patient history and symptoms combined with slit-lamp eye simulation for enhancing the clinical training of students

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**ABSTRACT**

**Clinical relevance:** Communication between eye care practitioners is essential to optimise health care. Traditionally, actors have been used prior to real patient exposure, but this is expensive and much training is needed to ensure a consistent student experience and assessment. Artificial intelligence using ChatBots is shown to provide a high-quality student experience, and due to their portability and cost, it has the potential to revolutionise communication training

**Background:** Augmented reality ocular examination simulations have been shown to be effective in teaching ophthalmology and optometry. With large language models, ChatGPT has been shown to provide effective role-play simulation. This study examined whether a combination of augmented reality and role-play simulation can enhance self-assessed competency of optometry students. It also assessed, the learning experience of students with role play by a human actor compared to different artificial intelligence chatbots.

**Method:** Sixteen final-year optometry students with limited experience of computer simulation completed three role-plays with each of a SimConverse artificial intelligence, ChatGPT artificial intelligence, and an actor patient, in randomised order. In each session, the scenario included a history and symptoms, related augmented reality slit-lamp biomicroscopy examination (EyeSi) of the 'patient's' eyes, followed by the student communicating their findings and intended actions with the 'patient'. Students completed pre- and post-questionnaires to rank their learning experiences.

**Results:** There were significant improvements ($p < 0.05$) over all aspects of clinical competence expectations ranked by students except 'prioritising key signs and symptoms' ($p = 0.66$). There was no significant difference between the role-play proved by an actor and SimConverse. However, students rated the ChatGTP simulation as providing a significantly poorer experience ($p < 0.001$).

**Conclusion:** Combining patient role-play with augmented reality simulation significantly enhances how students feel about their clinical competencies. Role-play by an artificial intelligence 'patient' can provide an equivalent learning experience as that provided by an actor.

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Artificial intelligence; clinical training; patient history and symptoms; slit-lamp eye simulation; students

## Introduction

Augmented reality ocular examination simulations are effective in the medical field teaching including ophthalmology and optometry.[1–6] Simulation allows the students to learn how to examine the health of the eye and experience what different eye diseases look like or perform various ocular procedures without relying on real patients. They also ensure exposure of the students to a wide variety of ocular pathology, which cannot be guaranteed in typical clinical placements.[7]

Pathologies are more readily perceived on a slit-lamp biomicroscope simulator, and students report that textbooks often do not properly display the three-dimensional location of the pathology.[8] However, compared with clinical placement, augmented reality simulation lacks the interactive experience of going through the history and symptoms of a patient, which is essential for making tentative diagnoses and planning for what particular signs to look for to reach a definitive diagnosis.[9,10]

Role-playing by clinical educators can fill in the gap.[11,12] Recently, artificial intelligence large language models (such as ChatGPT) have been adopted for role-play medical simulation in clinical training of history

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and symptom taking.[13–16] ChatGPT has been shown to provide higher-quality simulations when subject matter experts are instructing it.[17]

While ChatGPT has been widely used, there are new artificial intelligence-driven platforms, specifically designed to enhance the communication skills of healthcare professionals through simulated patient interactions. One such platform, SimConverse (Melbourne, Australia), allows patient history and symptoms to be fed to the artificial intelligence chatbot, which leads to a more case-specific simulation of history and symptom interaction. It can provide a transcript of its 'conversation' with the student and can provide comprehensive and consistent feedback against a pre-programmed assessment rubric.

The current study aimed to compare augmented reality slit-lamp biomicroscopy simulation combined with the role-play by a clinical educator actor or artificial intelligence-driven history and symptom simulation by ChatGPT or SimConverse. The results of this study inform the pedagogical design of clinical training and preparation for supervised and independent clinical eye care practice.

## Methods

### *Study design and procedures*

In order to achieve 80% power with a 1–10 scale questionnaire, assuming a standard deviation of two and an expected mean difference of two, 16 participants were required for this study.

An invitation email was sent to all final-year optometry students from the School of Optometry, Aston University, Birmingham, United Kingdom, by the principal investigator, and 16 students were recruited and consented to join the study.

The study was approved by the research ethics committee of Aston University, and the research conformed to the tenets of the Declaration of Helsinki.

Inclusion criteria included: two academic years of basic knowledge regarding history and symptom taking and slit-lamp biomicroscopy operation from a regulated professional optometry course; no previous experience in either an artificial intelligence simulation or an augmented reality slit-lamp biomicroscope simulation; and less than 1 month of clinical experience in an eye clinic.

A brief introduction to how to operate the Eyesi® Slit-Lamp simulator (VRmagic Holding AG, Mannheim, Germany) was conducted before the study started.

### *Pre-questionnaire*

Before the start of the simulation, students were asked to complete a questionnaire in the form of an online questionnaire on Microsoft Forms (Microsoft Crop, Redmond, USA) rating what they expected to gain from the simulation session in different competency areas (Table 1). The questionnaire domains of tangibility, reliability, responsiveness, assurance, and empathy were based on, and adapted from, the ServQual concept of service perceptions to address the study aim.[18]

Students were asked to rate what they felt they had gained on the same competencies after the simulation, based on their reflection of self-assessed competency and learning experience, so that the gaps could be identified.

### *History and symptoms with EyeSi simulation*

Students were randomly assigned to the three different ocular conditions – blepharitis, keratoconus, and early wet age-related macular degeneration – presented in the augmented reality slit-lamp biomicroscope simulator. Matched role-played history and symptoms were randomly assigned to be delivered by a clinical educator actor (expert simulated patient), artificial intelligence patient simulation by SimConverse or artificial intelligence patient simulation by ChatGPT (ChatGPT-4o, accessed between 27 September 2024 and 25 October 2024). ChatGPT responded consistently during the different sessions, with no obvious order effect found during the experimental period.

After the students had completed the Eyesi Simulation, they were required to give feedback to the 'patient' on their findings and management plan. The scenario feedback was provided verbally

Table 1. Questions in the pre-questionnaire.

| | |
|---|---|
| Instruction<br>Please read the statements below and think about what you expect to gain from the simulation session.<br>All the questions require answers on a scale of 1 to 8.<br>If you feel that the statement is something you do not expect to gain from the session, answer 1, if you feel that the statement is something you absolutely expect to gain from the session, answer 8.<br>There are 6 sections in this questionnaire, please finish them all, thank you very much for your help. | |
| Tangibility<br>This session will improved my ability to | |
| 1. | identify ocular pathology |
| 2. | manage ocular pathology |
| Reliability<br>This session will improved my ability to | |
| 3. | identify differential diagnoses |
| 4. | make a correct diagnosis |
| 5. | develop appropriate management plans |
| Responsiveness<br>This session will improved my ability to | |
| 6. | prioritise key signs and symptoms |
| 7. | understand my limitations and when to refer the patient |
| Assurance<br>This session will improved my ability to | |
| 8. | offer advance and reassurance to patients |
| Empathy<br>This session will improved my ability to | |
| 9. | understand the emotional and physical impact of the condition and management on the patient |
| 10. | adapt my communication style to the needs and concerns of the patient |
| 11. | adapt my management plan to the needs and concerns of the patient |

by the expert simulated patient (actor), and performance against a rubric was provided by SimConverse or text feedback was provided by asking ChatGPT. The students performed a second and third case in random order so that all students experienced each type of role-play and each of the three conditions.

Each case simulation lasted 30 minutes, comprising 10 minutes for the history and symptom element, 10 minutes on the slit-lamp biomicroscope, 5 minutes explaining their findings to the patient and 5 minutes receiving feedback. The whole session lasted about 2 hours, including the introduction to the Eyesi simulator and filling in the questionnaires (Figure 1).

### *History and symptom script*

The prompt was 'Can we do a role play while you are a naive patient with keratoconus/anterior blepharitis/wet ARMD and I am the optometrist. I am going to ask you questions and explain the management to you?' with ChatGPT version 4-o. If the simulation is successful, ChatGPT will response 'Sure, let's start the role play. You can begin by asking me questions as the optometrist, and I'll respond as a naive patient with keratoconus'. The answers of the history by ChatGPT with that prompt were verified by the principal investigator to be reasonable answers in the preparation stage; the answers, including symptoms elicited, were comparable to the script prepared for the expert simulated patient and SimConverse.

The participating student spoke to the ChatGPT with Microsoft Dictation Tool (Windows 10; Microsoft Corp, Redmond, USA) to interact with ChatGPT after inputting the prompt phase in the study (not seen by the participating student). ChatGPT then responded to the history and symptom questions and the management presented by the student.

The training with SimConverse is conducted by programmers within the SimConverse company; a detailed script including questions and answers for history and symptoms together with a detailed management plan (which was also shared with the actors) was required to let the programmer know what answers should be given by the artificial intelligence patient for given questions. A marking rubric was also prepared for SimConverse with an artificial intelligence feedback system.

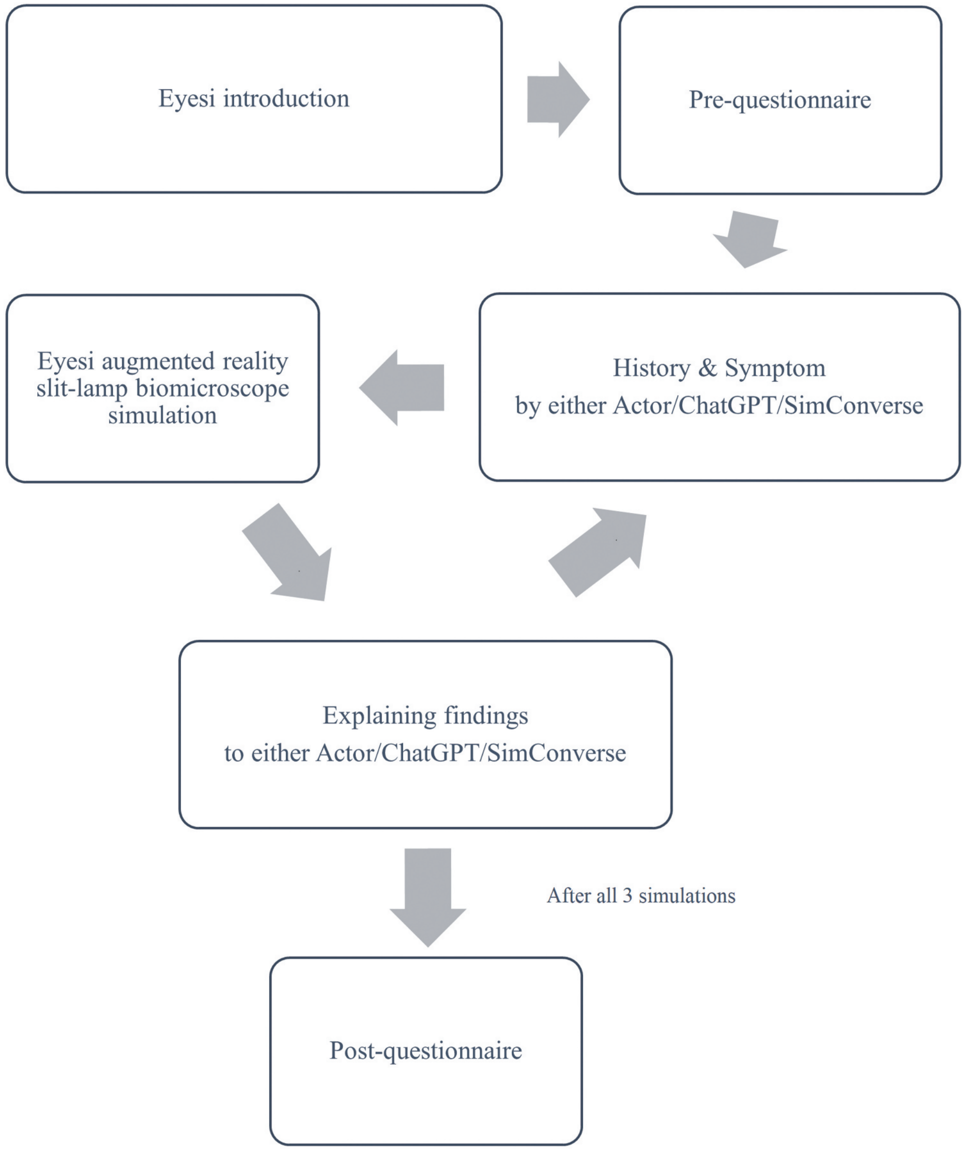


Figure 1. The flow of simulations during the session.

### *Post-questionnaire*

After students finished all simulations (including the communication and augmented reality aspects) and received feedback from different simulations, they are asked to fill in a questionnaire (with the same questions as in the pre-questionnaire, but phrased as "The session has improved my ability to:") with six additional questions to rate their learning experience and the feedback received from the role-play by the clinical supervisor and artifical intelligence platforms SimConverse and ChatGPT (Table 2).

### *Data analysis*

The collected data were exported from Microsoft Forms to Microsoft Excel (Microsoft, 2023) and then imported to SPSS (version 29.0.1.0, SPSS Inc., Chicago, Illinois, USA) for analyses. Descriptive statistics, which include median and interquartile ranges, were used to summarise the study variables. As the questionnaire data were ordinal in nature, Wilcoxon's signed rank test was used to determine if the competency scores were different before and after the simulation session. Friedman's two-way analysis of variance by ranks was used to determine which type of history and symptom simulation and which type of

Table 2. Additional questions in the post-questionnaire for students to rate their simulation experiences. Questions 1–11 are the same questions as the pre-questionnaire listed in Table 1 but phrased as "This session has improved my ability to:".

| | |
|---|---|
| Please rate your learning experience with the following simulation method: If you feel that you have a terrible learning experience from the session, please answer 1, if you feel that the learning experience is excellent, please answer 10. | |
| 12. | Simulation with an actor |
| 13. | Simulation with SimConverse |
| 14. | Simuation with ChatGPT |
| How would you rank the feedback given by the simulation? If you feel that you have a terrible learning experience from the session, please answer 1, if you feel that the learning experience is excellent, please answer 10. | |
| 16. | Feedback by the actor (verbal feedback) |
| 17. | Feedback by the SimConverse (by showing the rubric) |
| 18. | Feedback by ChatGPT (by giving potentially missed information) |

feedback the students felt most enhanced their competencies compared to their expectations. Results were considered statistically significant if $p < 0.05$.

## Results

### *Self-assessment by students of the competencies they expect to gain before a simulated training experience and those they achieved afterward*

For the self-reflecting questions, students reported greater improvement in all competencies than expected ($p < 0.05$) except prioritising key signs and symptoms ($p = 0.66$) (Table 3). This included a significant increase above the expected score for identifying ocular pathology ($p = 0.001$), managing ocular pathology ($p = 0.03$), identifying differential diagnoses ($p = 0.004$), making a correct diagnosis ($p < 0.001$), understand my limitations and when to refer the patient ($p = 0.007$), offer advice and reassurance to patients ($p = 0.002$), understand the emotional and physical impacts of the condition and management on the patient ($p = 0.002$), adapt my communication style to the needs and concerns of the patient ($p = 0.013$), and adapt my management plan to the needs and concerns of the patient ($p = 0.022$).

### *Rating by students of the different history and symptoms simulations*

There were significant differences between different methods of history and symptom simulations as rated by the students ($p < 0.001$). Pairwise comparison showed a significant difference between ranking by students with the simulation by ChatGPT (median = 6, IQR 5–8) with both simulation by an actor (median

Table 3. The score of the questions from the questionnaire before and after the simulation.

| | | Before | | After | | |
|---|---|---|---|---|---|---|
| | | Median | IQR | Median | IQR | *P* value |
| | **Tangibility** | | | | | |
| 1. | identify ocular pathology | 6.5 | 5.3–7.0 | 8.0 | 7.0–8.0 | $p = 0.004$ |
| 2. | manage ocular pathology | 6.5 | 5.0–7.0 | 8.0 | 7.0–8.0 | $p = 0.001$ |
| | **Reliability** | | | | | |
| 3. | identify differential diagnoses | 7.0 | 5.3–8.0 | 8.0 | 6.3–8.0 | $p = 0.03$ |
| 4. | make a correct diagnosis | 6.0 | 5.0–7.8 | 8.0 | 7.0–8.0 | $p = 0.004$ |
| 5. | develop appropriate management plans | 6.0 | 5.0–7.0 | 8.0 | 7.3–8.0 | $p < 0.001$ |
| | **Responsiveness** | | | | | |
| 6. | prioritise key signs and symptoms | 7.0 | 6.0–8.0 | 7.5 | 7.0–8.0 | $p = 0.66$ |
| 7. | understand my limitations and when to refer the patient | 6.0 | 5.3–7.0 | 7.5 | 6.3–8.0 | $p = 0.007$ |
| | **Assurance** | | | | | |
| 8. | offer advance and reassurance to patients | 6.5 | 5.0–7.0 | 8.0 | 7.0–8.0 | $p = 0.002$ |
| | **Empathy** | | | | | |
| 9. | understand the emotional and physical impact of the condition and management on the patient | 6.0 | 5.0–7.0 | 7.0 | 7.0–8.0 | $p = 0.002$ |
| 10. | adapt my communication style to the needs and concerns of the patient | 6.5 | 6.0–7.8 | 8.0 | 7.0–8.0 | $p = 0.013$ |
| 11. | adapt my management plan to the needs and concerns of the patient | 6.0 | 5.3–7.8 | 7.0 | 6.3 | $p = 0.022$ |

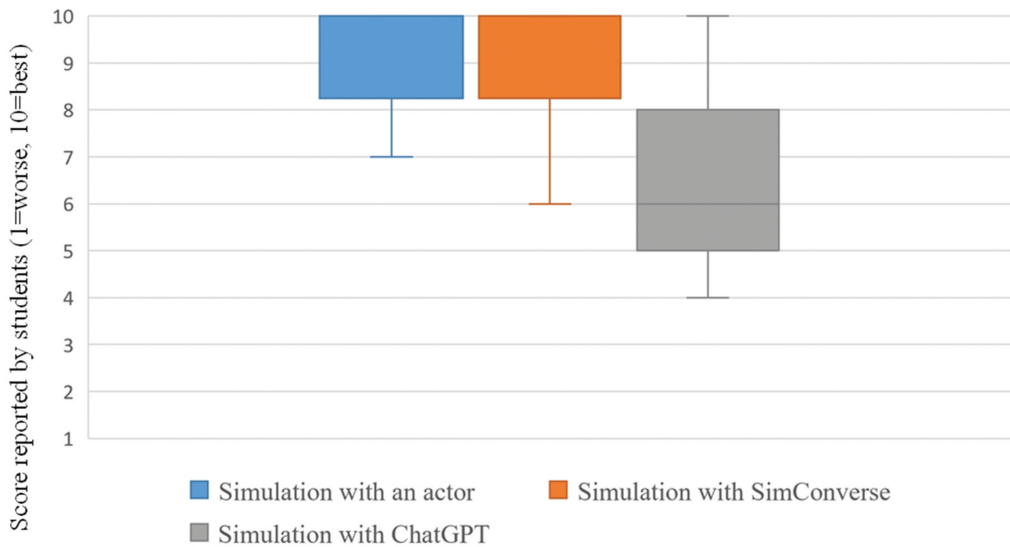


Figure 2. Comparison of the rank by students of different simulations of history and symptoms.

= 10, IQR 8–10, $p = 0.003$) and simulation by SimConverse (median = 10, IQR 8–10, $p = 0.031$). There was no significant difference between ranking by students of simulation by a clinical supervisor and simulation by SimConverse (Pairwise comparison, $p = 0.48$, Figure 2).

## Rating by students of the feedback provided by the different simulation modes

There were significant differences between feedback provided by the different simulations as rated by the students ($p < 0.001$). There is a significant difference between ratings by students of the feedback from ChatGPT (median = 4.5, IQR 3–6) from both the feedback given by an actor (median = 9.5, IQR 8–10, $p < 0.001$) and the feedback provided by SimConverse (median = 10, IQR 9–10, $p < 0.001$). There was no significant difference between the ratings given by students of the feedback given by the actor and SimConverse ($p = 0.86$) (Figure 3).

## Discussion

### *Advantages of training with combined role-play with augmented reality eye simulation*

This study showed that a combination of history and symptom role play with augmented reality anterior eye simulation outperformed student expectations of the clinical competencies they would gain from a 2-hour training session. This approach trains clinical reasoning through history and symptoms with the management of the related case in the Eyesi simulator[19] while the augmented reality slit-lamp biomicroscope allows students to experience the signs matched to the tentative diagnoses.[1,2]

Students came up with the final diagnoses and developed an appropriate management plan. Students then needed to explain the diagnosis and management to the ‘patient’. At this point, students can also learn how to break bad news to patients through this active learning simulation approach (as the student self-reported significant improvement in ‘understanding the emotional and physical impact of the condition and management on the patient’ in the questionnaire).[20]

Combining history and symptoms (either by expert patients or artificial intelligence ‘patients’) simulation with Eyesi slit-lamp simulation could be a more holistic approach in clinical simulation training and also enhance patient safety by letting the students learn from their mistakes during the simulation, reducing the likelihood of errors in real-life clinic placement.[21] This type of simulation can also provide standardised training as the simulation offers a controlled environment where all the students can experience the same clinical scenarios, especially with artificial intelligence ‘patients’ such as SimConverse.[21]

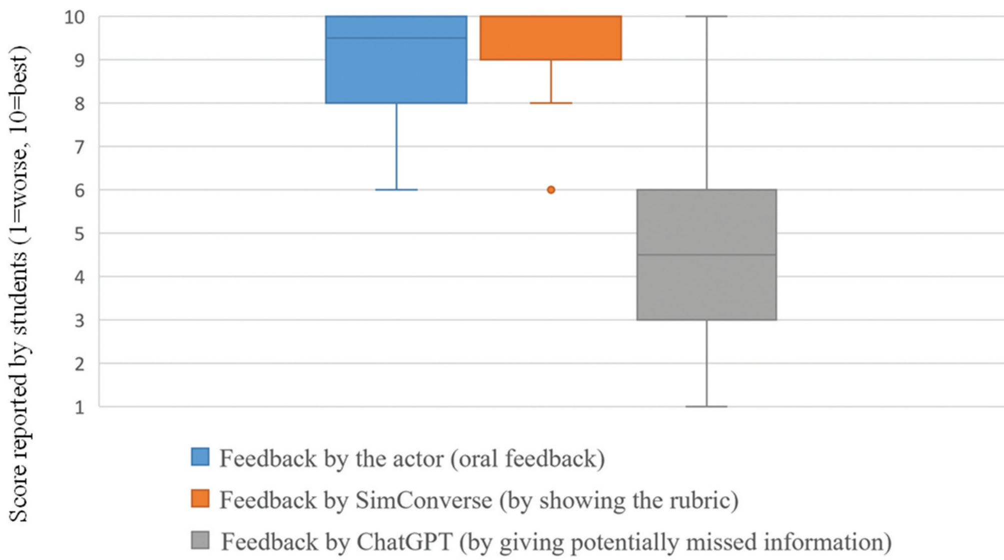


**Figure 3.** Comparison of the overall learning experience by students with different types of simulation.

### *Artificial intelligence patient compared to a clinic educator for role-playing simulations*

There was no significant difference in the student experience on the role-play simulation with an actor and SimConverse artificial intelligence patient. The newer generation of artificial intelligence chatbot technology can significantly improve the simulation experience through machine learning; SimConverse artificial intelligence 'patients' can be trained to give consistent responses to particular questions according to the need of the simulation.

The SimConverse artificial intelligence 'patients' can also react to students with different attitudes such as being annoyed, scared, or intimidated, for example, leading to the conversation generated being more human-like without the pauses of a typical artificial intelligence chatbot. This is the first study to show that simulation experience can be as good as a human actor. The potential advantages of using SimConverse artificial intelligence for 'patient' are the lower running cost compared to human actors (in the long run as the maintenance cost is lower) and the opportunity for students to practice in their home setting.

Also, SimConverse artificial intelligence/'patient' responses can be more consistent compared with human actors; in order to obtain similar consistency, rigorous and standardised training protocols for human actors are needed.[22] Students have the same performance in pharmacy simulation between a paid actor (non-expert in the field) and a staff member, faculty member, or a student from a high-level cohort in pharmacy; however, students preferred the latter as experts playing the patients remained more professional and gave better feedback to the students.[23]

With SimCoverse artificial intelligence 'patients', staff faculty were required to train and program the responses and the feedback rubrics, leading to a better simulation experience. The current study used experienced actors, so it is possible that less experienced actors may not be comparable to the SimConverse artificial intelligence simulation. This could also give this software an advantage over the Chat-GPT 'patient' simulation; however, a recent study reported that even with proper prompts given to Chat-GPT, it could still fail to act like a real 'patient' with responses lacking in emotion and responses given with wrong information.[24]

Also, using an actor for simulation could be resource intensive, as the actor needs to be well-trained or even a professional in the field for the best simulation. Logistic arrangements with the actor and students during the simulation could also make role-play less practical, and this is even more likely when a large number of students are involved, as Aston Optometry School has about 140 students in each year of its undergraduate course, with only a 26-week teaching period to schedule the simulation sessions with expert patients.[25] It could also have an emotional or fatiguing impact on the actors, as they need to repeat the same role multiple times, with some research suggesting that portraying patients with serious or complex conditions can have psychological effects on the actors.[22]

This study found no significant difference with the experience between simulation experience with an actor and an artificial intelligence 'patient', which makes artificial intelligence patient simulation an excellent future option for this type of simulation. On the other hand, simulation with the artificial intelligence 'patients' gives greater flexibility to student learning, as they only require a connection to the internet with either a computer or a mobile phone.

Advances in artificial intelligence such as voice-responsive avatars will further enhance future artificial intelligence roleplay. The only potential disadvantage involved would be the cost of training and programming the artificial intelligence 'patient' and the associated running costs; as the artificial intelligence 'patients' provided by SimConverse are charged by the number of student interactions, careful planning and budgeting would be desirable in the long term for including this kind of simulation in the curriculum.

Aside from the budgeting concern, the initial time training and programming of the artificial intelligence 'patients' is long; however, once the artificial intelligence 'patients' are properly trained or programmed, these can be reused and shared with other training programmes.

### *Feedback provided by an actor compared to artificial intelligence simulation*

There is no significant difference between how students ranked the feedback by the actor (a clinical supervisor) and SimConverse, even though the nature of the feedback was different; verbal feedback was given by the actor compared to written rubric-type feedback by SimConverse. Both forms of feedback have previously been shown to be similarly effective.[26–30]

ChatGPT provided unstructured and non-interactive feedback, which as unsurprisingly reported to be less effective by the students when compared to verbal feedback from the clinical experts or well-structured feedback delivered by SimConverse.[31,32] Verbal feedback can be used to reinforce good practices[26] and self-assessment ability.[28] Rubric feedback can enhance alignment with the learning outcomes,[33] improve consistency, and facilitate self-assessment and reflection by the students.[34] The transcript of the conversation minimises disputes between the student and assessor and can provide other useful metrics such as timing.

## Conclusion

Students found that combining role-play with augmented reality slit-lamp biomicroscope examination simulation outperformed their competency-based expectations. Using enhanced artificial intelligence 'patients' can be as good as clinically trained actors (a clinical supervisor) in history and symptoms and management role-play simulations. Feedback given by the artificial intelligence platform by rubrics can be equally effective compared to verbal feedback given by the clinical supervisor during simulation.

## Disclosure statement

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