SIMBA for Students – teaching medical cases to pre-clinical medical and pharmacy students through online simulation: a pilot study

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Abstract

Background

Simulation-based learning (SBL) is superior to Small-group teaching (SGT) in training adaptability, situation awareness, critical assessment, and management. Simulation via Instant Messaging - Birmingham Advance (SIMBA) is a novel SBL approach that improves healthcare professionals' applied learning skills. We adapted the SIMBA as a learning model for undergraduate medicine and pharmacy students. The performance and acceptance of SIMBA was compared to SGT.

Methods

SIMBA followed Kern et al.'s six-step conceptual framework and blended elements of the simulation game with Kolb's experiential learning theory. All SIMBA and SGT sessions conducted for pre-clinical medical and pharmacy students from October 2020 to March 2022 were included. Knowledge gain and students' acceptance of SIMBA and SGT were measured through multiple-choice questions (MCQs) and post-session surveys. The median MCQ score was compared between groups using Wilcoxon signed rank test.

Results

130 students attended 14 SIMBA sessions. After attending SGT sessions corresponding to SIMBA sessions, 150 students responded to post-SGT survey. Of these, 38 attended both SIMBA and SGT. Post-SIMBA MCQ scores were higher than post-SGT only (median: 75.0% vs 60.0%, $p < .0001$). MCQ scores were similar between those who attended only SIMBA and both SIMBA and SGT (75.0% vs 63.3%, $p = .0731$). Students reported SIMBA sessions were more enjoyable (89.2%), easier to follow (90.8%), engaging and interactive (81.5%), promoted new knowledge (90.0%), and provided a deeper understanding (93.9%) compared to SGT.

Conclusions

SIMBA demonstrated superiority over SGT for teaching endocrinology to pre-clinical medical and pharmacy students, offering advantages such as enhanced knowledge acquisition, engagement, and interaction.

Background

The traditional approach to medical education with lecture-based learning (LBL) focuses on developing scientific theory in the initial years before clinical experience (1). However, the lack of clinical exposure may limit the application of knowledge at the time of acquisition (2). Several studies have shown the

effectiveness of case-based learning in integrating basic and clinical sciences in the preclinical medical curriculum (3, 4). To facilitate this, many medical schools introduced small-group teaching (SGT). Typically, SGT is provided after lectures moderated by a facilitator, allowing students to address gaps in knowledge and explore questions based on the topics covered in small groups (5). Burgess et al. recommend that SGT incorporates three elements: active participation, 'face-to-face' contact between participants and purposeful activities (6). However, active participation may pressure students to participate in group activities constantly (6, 7).

Further, several medical schools employ a parallel SGT approach wherein different tutors simultaneously teach the same session to different groups of students (6). Depending on the facilitator and students' engagement, this can result in differential knowledge gain. SGT also has additional limitations, such as inconsistent group dynamics and varied student preparedness (5). Time and resource constraints may further limit the number of sessions conducted and their scalability.

Simulation-based learning (SBL) is an educational approach utilising a simulated environment to provide immersive practical experiences for participants. Technological platforms have been used to teach with a simulation approach that allows clinical exposure in a safe and realistic setting (2). Simulation-based learning (SBL) augments clinical performance, attitudes, and teamwork, ultimately helping improve patient outcomes (8). Several studies have highlighted the superiority of SBL to LBL in training adaptability, situation awareness, critical assessment, and management (9–11). SBL enhances interpretation and knowledge retention compared to watching recorded content (12). While texting is not inherently SBL, combining it with interactive and immersive simulation elements and debriefing the case scenarios can help learners foster decision-making skills.

Simulation via Instant Messaging - Birmingham Advance (SIMBA) is a novel simulation-based learning approach using WhatsApp to increase participants' confidence in clinical scenarios (13). SIMBA is based on the simulation game (14) and Kolb's experiential learning theories (15), incorporating interprofessional education, using minimal resources and sustained medical education even during the pandemic (16, 17). Previous sessions have focussed on postgraduate healthcare professionals demonstrating that SIMBA is an effective teaching model which leads to sustained improvements in clinical knowledge (13, 18, 19).

In this study, we report our experiences of adopting the SIMBA model to deliver applied learning to undergraduate medical and pharmacy students using the six-step conceptual framework described by Kern et al. (20). We report the acceptance and change in knowledge post-SIMBA in comparison to SGT.

Methods

We developed the SIMBA for Students model from October 2020 to April 2023 using the six-step conceptual framework described by Kern et al. (20, 21) (Fig. 1).

Problem identification and general needs assessment

The Institute of Metabolism and Systems Research, University of Birmingham, delivers SGT for endocrine-related topics to year 1 and 2 medical and pharmacy students. We met with the institute's medical education director and his team to understand the current SGT model, its strengths, and its limitations. Whilst SGT had the benefits of face-to-face contact between participants and purposeful activities, the current delivery lacked active participation due to inconsistent group dynamics and varied student preparedness. Tutors were adequately prepared for the SGT. However, a variation in the level of engagement with the students may exacerbate the differential gain from SGT.

Targeted needs assessment

We identified the need for a better model which provides active participation whilst overcoming the limitations of SGT. SIMBA's success in improving the self-reported confidence of healthcare professionals (13) provided a platform to deliver a similar model for undergraduate students as an alternative to SGT. We approached the team responsible for delivering lectures and SGTs for endocrine-related conditions for undergraduate medical students with a draft proposal of the working model. After several discussions and revisions, a working model was finalised (Fig. 2).

Goals and objectives

We aimed to develop a model based on SIMBA that would improve engagement, stimulate interest, utilise modest resources, and result in a minimum additional workload for students and teachers. We assessed students' change in knowledge with SIMBA compared to SGT, and acceptance of SIMBA for students as an educational model.

Education strategies

The SIMBA for Students model is based on a combination of the simulation game and Kolb's experiential learning theories (14, 15) (Fig. 3). A simulation game is defined as the effects of decisions made by participants that are interrelated with a system of rules and references to resources that realistically symbolise reality (14). Kolb's Learning Cycle is a pedagogical approach or model of human learning developed by David Kolb (15). The first stage of Kolb's four-stage experiential learning theory—concrete experience—is the simulation session where the participants could work through realistic case scenarios via WhatsApp. The second stage of Kolb's cycle—reflective observation—refers to an expert discussing each case with evidence-based rationale on Zoom. In the third stage of Kolb's cycle of abstract conceptualisation, the assimilation of the new information is facilitated by the completion of multiple-choice questions (MCQs) in the Post-SIMBA survey. The fourth stage of Kolb's learning cycle—active experimenting—is demonstrated by participants building on their simulation experience and applying their knowledge during clinical practice.

Implementation of the model

Standardised transcripts were prepared by the SIMBA for Students team based on content (adrenal, diabetes, metabolic bone, thyroid, reproductive endocrinology, bone, and calcium) included in the lectures

delivered to students. Each transcript included 3 case scenarios, each with 10 questions exploring a topic relating to the overarching theme of the session. An expert in the relevant field validated all transcripts to ensure accuracy.

A student session lead, a senior expert, and student moderators facilitated each SIMBA session. To ensure efficiency and accuracy during the session, all moderators were trained in advance of the session by the team's moderator leads using the finalised transcripts.

The sessions were advertised to students via emails from the university to the relevant cohort. This information was further cascaded to relevant groups by fellow students through social media. Students interested in participating completed informed consent and registered via a Google Form to participate in the study. The form was closed 24 hours before the session, and all participants were allocated a moderator. Each moderator was responsible for up to five participants based on their experience and expertise to moderate. The moderators were provided with the assigned participants' anonymised SIMBA IDs and WhatsApp numbers.

On the day of the session, moderators introduced themselves to participants via standardised text one hour before the session. Following this, moderators shared the agenda for the session via WhatsApp. Five minutes before the session, a Zoom link for the "Opening Welcome" was sent to the students. In the "Opening Welcome" Zoom call, the students were introduced to SIMBA and what the session involved. Following this, moderators sent an image as a signal to start the simulation (Fig. 4). The case simulation was initiated once the participant confirmed they were ready.

There were typically three cases per session, with a two-minute break between each case. Each case simulation lasted 15 minutes and was stopped after this time, regardless of whether the participant completed all questions. If the participant did not complete the simulation in the stipulated time, the remaining content was provided to the student at the end of the session so they could review the content afterwards. The moderators interacted with participating students and provided them with appropriate scenarios followed by questions. Once the student answered the question, the moderators provided them with model answers. The moderators did not judge the response of participants in any manner and remained neutral throughout the session. This continued until the end of the simulation scenario. At the end of each case, students were asked if they had any queries about the case. All comments were compiled and shared with the expert leading the discussion.

After the simulation, participants were invited to Zoom for discussion. The senior expert summarised salient learning points for each case, followed by an opportunity for participants to ask questions about the case or general questions related to the topic. This lasted 10 minutes for each case.

Evaluation and feedback

Feedback is the core of the SIMBA model, and participants must complete a feedback form with a combination of closed and open-ended questions. After the session concluded, participants were invited to complete the post-SIMBA survey. The participants were asked to comment on various aspects of the simulation session on a five-point Likert scale. At the end of the survey, 10 MCQs were included to assess the participant's knowledge after the SIMBA session. These questions were based on the undergraduate curriculum and validated by the senior expert involved in the session. All students in the year were invited to complete a similar survey, including the same multiple-choice questions following the related SGT organised and delivered by the University.

Statistical Analysis

The survey responses were grouped among those students who attended SIMBA, SGT, both SIMBA and SGT (SIMBA + SGT) and SGT only. Closed questions in the surveys used a five-point agree-disagree Likert scale. Responses were grouped into "agree" (strongly agree and agree), "undecided" (undecided) and "disagree" (strongly disagree and disagree). Responses were then expressed as percentages and plotted on a stacked bar chart with percentages on the x-axis as a bar for both post-SIMBA and post-SGT on the y-axis. Descriptive statistics expressed as a percent and Comparative box and whisker diagrams were created using Stata version 17.0 for Mac comparing post-SIMBA and post-SGT scores, SGT only and SIMBA + SGT scores, and post-SIMBA and SIMBA + SGT scores. The difference in MCQ scores between groups was analysed using Wilcoxon sign-rank test.

Responses from open-ended questions were analysed using a single coder inductive thematic analysis. Material collected from both surveys was read and familiarised individually. Similar responses were grouped and assigned labels based on the main points systematically, and recurrent labels were collated into themes. The themes identified are presented in the analysis, including examples from both post-SIMBA and post-SGT surveys encompassing the opinions expressed.

Results

A total of 130 students attended 14 SIMBA sessions between October 2020 and March 2022. 150 students responded to the post-SGT survey after attending the corresponding SGT sessions. Of these, 38 had also attended the related SIMBA session.

The median (IQR) MCQ scores post-SIMBA, post-SGT only and post-SIMBA and SGT were 75.0% (60.0-86.7%), 60.0% (46.7–73.3%) and 63.3% (46.7–73.3%), respectively. Post-SIMBA scores were significantly higher than post-SGT only ($p < .0001$) (Fig. 5a). There was no significant difference in the MCQ scores between those who attended only SIMBA and those who attended both SIMBA and SGT ($p = .0731$) (Fig. 5b). Similarly, there was no significant difference between students who attended SGT only and those who attended both SGT and SIMBA ($p = .0542$) (Fig. 5c).

Students enjoyed both SIMBA (89.2%) and SGT sessions (87.9%). Most students who attended SIMBA thought that the session was easy to follow (90.8%), engaging and interactive (81.5%), promoted new

knowledge (90.0%) and created a friendly environment to ask questions (84.6%). Students thought that SIMBA stimulated more interest in endocrinology than SGT sessions (81.5% vs. 73.2%) and provided a more in-depth understanding of topics covered than SGT sessions (93.9% vs. 83.9%). 63.1% of students thought that the time allocated for each SIMBA case was sufficient, compared to 81.2% for each SGT case. 83.1% of students would like to have SIMBA as an adjunct to their usual SGT sessions and overall, more students felt better prepared for the endocrine topic covered post-SIMBA (86.9%), compared to post-SGT (49.7%).

Positive themes identified in the thematic analysis of open-ended questions revealed that students reported that SIMBA facilitated interactive learning, application of knowledge applicable to clinical scenarios, instant feedback, and enjoyment in case-based learning. SGT benefitted from working in small groups and the content acting as a peer discussion prompt (Table 1a). Suggestions to improve SGT focused on the need for instantaneous feedback, increased tutor support and presence, as this was variable amongst groups, a clear structure and timing for sessions and clear guidance on prior preparation (Table 1b). Suggestions for improvement of SIMBA focused on personalised moderator interaction, case content and session timing, suggesting both improvements to timing during the session and about the curriculum (Table 1c).

Table 1

Tables showing thematic analysis and student responses to open-ended questions. **1a**: Question: *What were the strengths of SIMBA for students and SGT?*

Theme	Responses: SIMBA for students	Responses: SGT
Interaction/ Engagement	Application of knowledge *"…SIMBA is also a better reflection of knowledge application "* *"Application of knowledge. Opportunity to develop better understanding"*	Discussion prompt *"Interaction with my peers and discussion helps consolidate my knowledge"* *"clinical correlations, invitation of open discussion"*
	Interactive learning *"I liked how the questions were interactive and answers were provided instantly"* *"More involvement and clear answers make learning clearer"*	Interactive session *"Interactive so easier to remeber, tutors are helpful"* *"Interactive and led by a specialist who deals with real life clinical scenarios "*
Session Format and Content	Case based learning *"Good to work through it as you would in real life rather than being spoon fed it in a SGT "* *"Case studies are useful in application of knowledge"* *"Case experience, "*	Facilitator input *" We are able to engage with the tutor to clarify any information but also expand with group discussion"* *"When there is a tutor they explain concepts I don't understand well when I ask questions. …"*
	Feedback and correction *"Instant feedback"* *"…I found it useful because after contributing our answers we were able to get some feedback answers too."*	Group Size *"Small groups so easy to contribute and easy to get feedback"*

1b: Question: *How could the SGT session have been improved?*

Theme	Responses
Session Support	Tutor Presence *“I would prefer more facilitator led discussions for difficult concepts”* *“I would prefer if more of the SGT's had a demonstrator like this one did as I found it really helpful”* *“Ensure a tutor for each session as some sessions without tutor are very difficult.”*
	Clear guidance on prior preparation *“More obvious on Canvas if we need to do any prep”* *“more guidance as to what is required before the session eg. read the sheet or answer the questions prior”*
Session Structure and Format	Session Feedback *“the time it takes to get feedback could be quicker (if possible - I know professors have busy schedules) or even having a teacher involved like the diabetes session today was quite nice “* *“Provide clear answers to the questions asked on the worksheets”*
	Clear Structure and Timing *“A clearer structure for the SGT. The explanation is always very wordy. A simple 1,2,3... step method for the SGT would be much easier to follow. …”* *“They should be a sufficient amount of time between the lectures and SGT as most times, I do not get to finish the lecture before doing the SGT”*

1c: Question: *How could the SIMBA for Students session have been improved?*

Theme	Responses
Timing	During session *"Slightly more time per case"* *"The length of time for each case as I didn't get to answer all of the questions."*
	In relation to curriculum *"They could be the week after the curriculum teaching for spaced repetition. "* *"Timing of session should coincide with end of teaching of all relevant material, so that all material has been learnt, and it can be used more as a revision/exam preparatory tool. In this case we had not covered the pharmacological aspect of diabetic treatment yet"*
Session Structure	Case content *"…The questions had way too much information (although good and informative) that sometimes wasn't that relevant to the question. "* *"Examples of misdiagnosis situations in which the typical treatment regimen should not be carried out and what alternatives to use."*
	Moderator interaction *"The responses are copied and pasted, the same for everyone. I think they should be personalised and address the students' answer "* *"Moderators could be less robotic"*

Discussion

SIMBA was superior to SGT for knowledge gain, as shown by significantly higher MCQ scores in the post-SIMBA group compared to post-SGT only. SIMBA also had higher student satisfaction compared to SGT. Attending both SIMBA and SGT did not lead to greater knowledge gain than SIMBA-only, suggesting that SIMBA may be sufficient as a stand-alone teaching modality.

To foster productive learning, teaching models and learning environments must be suited to the target audience; younger generations prefer technology-assisted learning (22, 23). SIMBA utilised available technology familiar to the younger generation and provided teaching in an environment more conducive to learning by efficiently combining e-learning and SBL.

The six-step conceptual framework helped to define and address the needs, goals, and objectives to deliver end-user feedback-driven simulation-based learning (20). Although combining the simulation game and Kolb's experiential learning theories helped deliver an engaging session (14, 15), open-ended feedback highlighted the need to ensure students attended the lectures before participation to maximise learning. We have therefore revised our model to include lectures as part of the concrete experience in future sessions. Stimulating interest to participate was difficult as students were occupied with pre-existing academic commitments. We will address this by involving the programme directors to

incorporate the model into routine academic requirements. We also could not measure the active experimentation stage of our learning model. A follow-up interview of participants to explore how they use the knowledge gained from SIMBA for Students during their interactions with patients at clinical placements can address this.

Interest is crucial in motivating learning, and the ability to stimulate interest in students is a powerful tool and one which is essential to academic success (24). Results showed SIMBA stimulated greater interest than SGT, which may have contributed to the significant increase in MCQ scores post-SIMBA sessions.

It is more valuable to the student when the information they are taking holds context and can be applied to the goal they are working towards (25). The SBL model of SIMBA provides learners to develop applied learning. Similar work elsewhere showed that virtual simulation tends to be well-received, with several studies indicating that students feel an improvement in clinical confidence. Nursing students participating in a virtual simulation teaching activity felt less pressured and inhibited by faculty and peers during the session (26). Unlike a real scenario, SBL provided a safe space to learn from mistakes, a critical aspect of the learning process. This sentiment was echoed by a study involving medical radiation sciences students, highlighting the importance of “safe practice in a low-pressure environment” (27). Preliminary results from the obstetric and neonatal simulation workshop suggest it may be valuable to integrate interprofessional education into teaching curriculums post-pandemic (28).

SIMBA is an accessible model that can be used by students and teachers from any location, at anytime, anywhere. This saves time, money, and valuable resources in an already strained academic and healthcare system. SIMBA’s adaptability also means that the model can be used for students in different countries with different healthcare systems, with previous SIMBA sessions shown to be effective in educating healthcare professionals worldwide (17, 18). This pilot study focussed on endocrinology, but our model can easily be expanded to cover any subject in the medical school curriculum (29). SIMBA has other advantages compared to SGT by avoiding issues such as individual students dominating the discussion, shy or disinterested students failing to contribute, and attention being directed toward the facilitator, who is expected to provide answers (6). SIMBA is standardised and delivers equal experiences to all students taking part, thus avoiding the issue of differential knowledge gain depending on which facilitator is allocated when multiple parallel sessions are run. Therefore, SIMBA could become the mainstay teaching modality after lectures.

Moreover, recently the SIMBA model has successfully been used for patient education. Whilst this study focuses on students, this can be vital in improving shared decision-making and patient outcomes (30). This paves the way for future sessions where students can work with patients to improve their shared decision-making skills.

This study may be subject to sample selection bias. As the session is voluntary and not part of the curriculum, those attending may be more diligent or higher-scoring students, resulting in better MCQ scores in SIMBA than SGT. Moreover, some students may have joined the session due to an interest in endocrinology or the unique style of teaching, thus leading to bias regarding whether the session

stimulated interest in endocrinology or whether the session was engaging and interactive. Suggestions for improvement for SIMBA mainly revolved around insufficient time allocated for each case and lack of personalised interaction. The time allocation for each case is based on the average time a student takes to complete all the questions. Undoubtedly, some students would take longer than others to answer and hence may not be able to complete some case scenarios. We, therefore, shared the remainder of the simulation that was not completed during the session to address this. Currently, it is difficult to incorporate personalised responses as not all moderators have the same clinical background. However, students have ample opportunity to have any questions regarding the cases to be addressed in the expert-led discussion session.

Conclusions

SIMBA demonstrated superiority over SGT in teaching endocrinology to pre-clinical medical and pharmacy students. It offers distinct advantages such as better knowledge acquisition, increased engagement, and enhanced interaction compared to SGT. The six-step conceptual framework described by Kern et al. (31) helped to define and address the needs, goals, and objectives to deliver end-user feedback-driven simulation-based learning. Future research will focus on diverse student cohorts across multiple specialities to evaluate the potential benefits and feasibility of adopting the SIMBA model in educational settings.

Abbreviations

LBL - Lecture-based learning

MCQs - Multiple-choice questions

SBL - Simulation-based learning

SGT - Small-group teaching

SIMBA - Simulation via Instant Messaging - Birmingham Advance

Declarations

Ethics approval and consent to participate

All methods were used per the Declaration of Helsinki. Written informed consent was obtained from all subjects. The Science, Technology, Engineering and Mathematics Committee of the University of Birmingham approved the study protocol.

Consent for publication

Not applicable

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare no competing interests.

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Authors' Contribution

AS and DZ are the joint first authors, having made all-round contributions to the study. TO analysed and interpreted the data analysis. PK conceptualised and supervised the delivery of all study aspects, and critically reviewed the manuscript. IA and GM led the organisation and running of several sessions. FR led the design and delivery of advertisements. HS created the forms and surveys to recruit moderators and participants and collect feedback and MCQ data. CC, TO and FA created transcripts used for the case simulations in each SIMBA session. AY and HK recruited and trained moderators for all SIMBA for students session. AS, IA, GM, TO, CC, AY, HK, HS, FA, and FR were members of the SIMBA for Students team involved in organising sessions and acting as core moderators. MD, EM, PAF and VD were involved in the review of session material, supervision of delivery and leading the discussion session. Members of the SIMBA and CoMICs team contributed substantially to the conception and design of the study and were involved in discussions at all stages of the study. This team includes Emily Warmington, Carina Pan, Pavithra Sakthivel, Vina Soran, Anisah Ali, Kashish Malhotra, Sung Yat Ng, Harshin Pallathoor Balakrishnan, Zahra Olateju, Maiar Elhariry, Sangamithra Ravi, Abby Radcliffe, Rachel Nirmal, Aditya Swaminathan, Shams Ali Baig, Dwi Delson, Soon Chee Yap, Vardhan Venkatesh and Fazna Rahman. The final version has been reviewed and approved by all the named authors.

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Figures

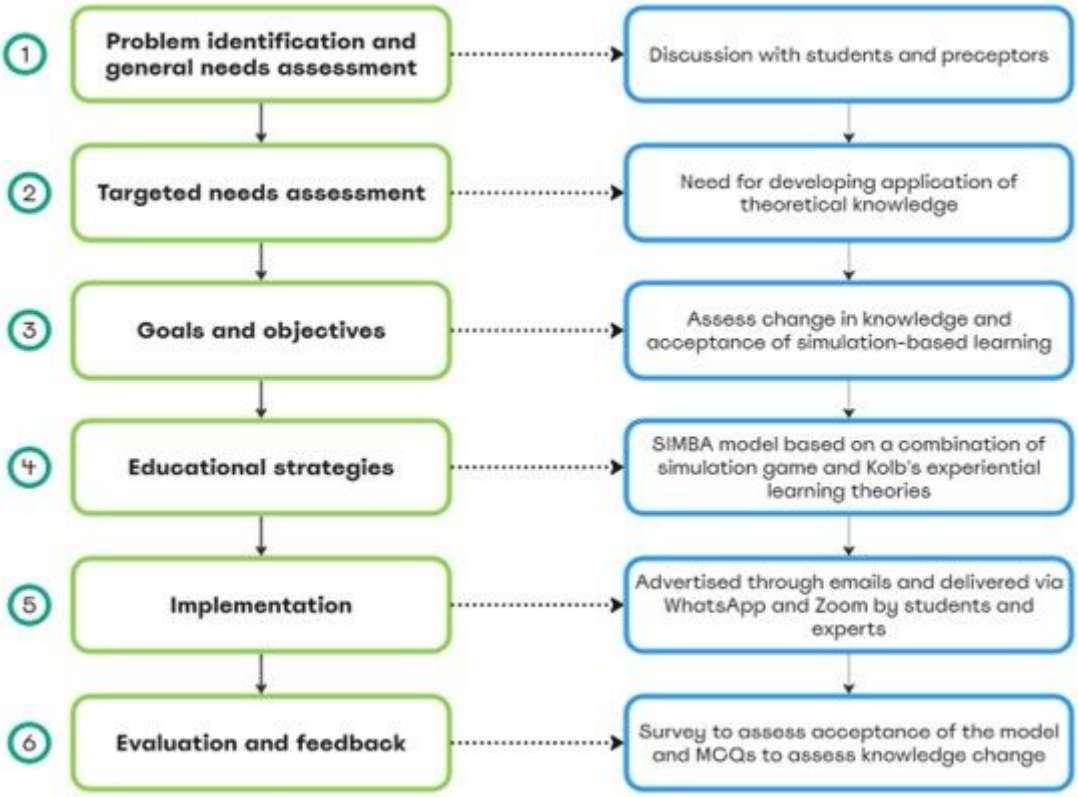

Figure 1

the six-step conceptual framework adopted to deliver SIMBA for Students based on Kern et al.

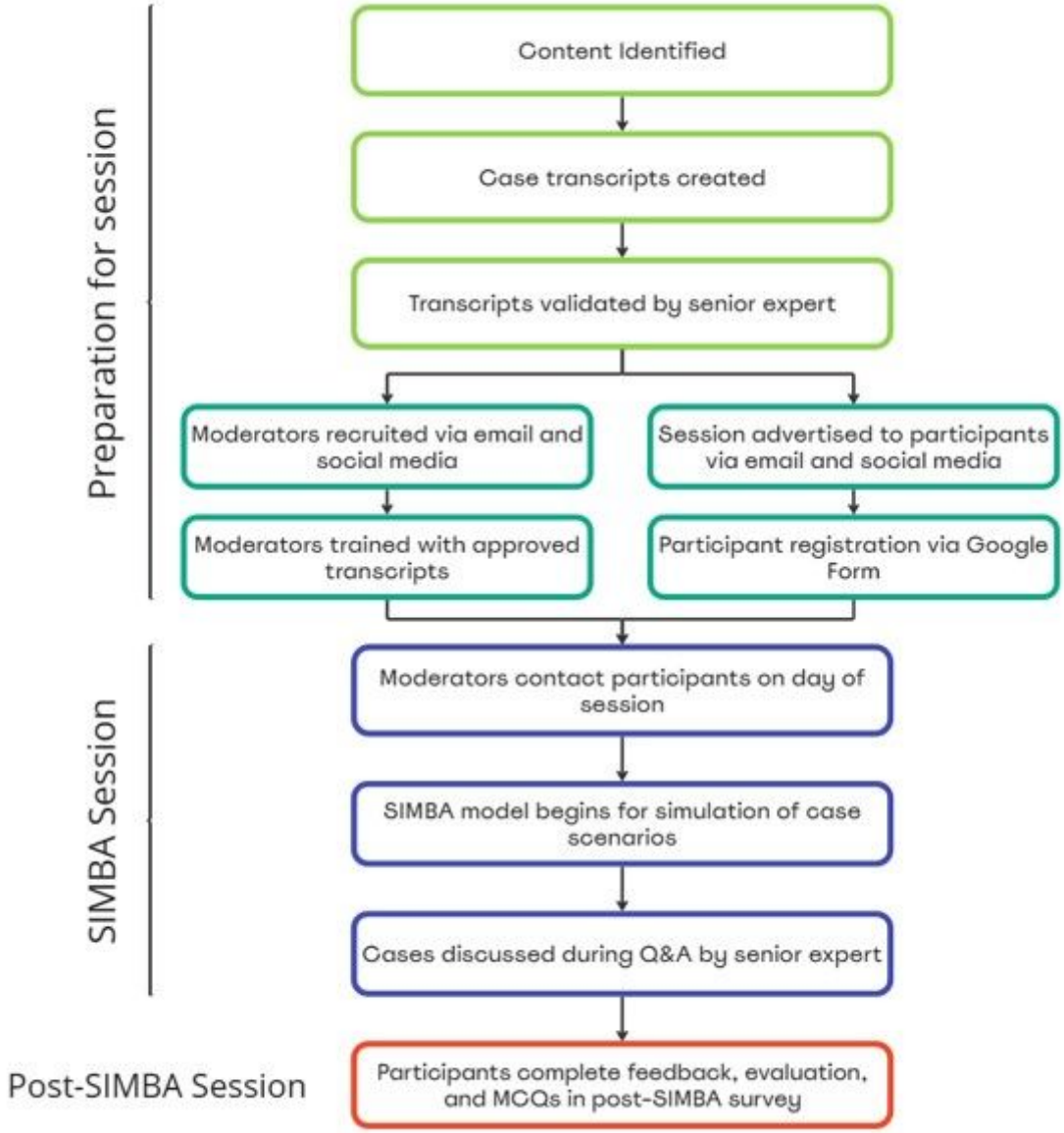

Figure 2

the implementation phase of six step conceptual framework based on Kern et al. describing the working model of SIMBA for students

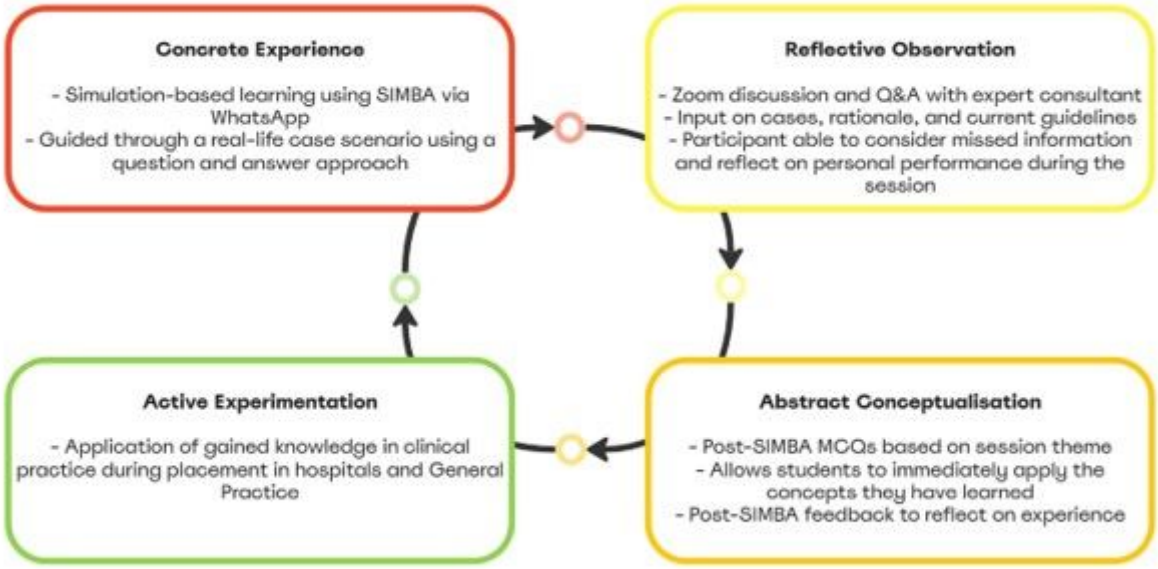

Figure 3

a visualisation of SIMBA for Students' educational strategy based on Kolb's experiential learning theory

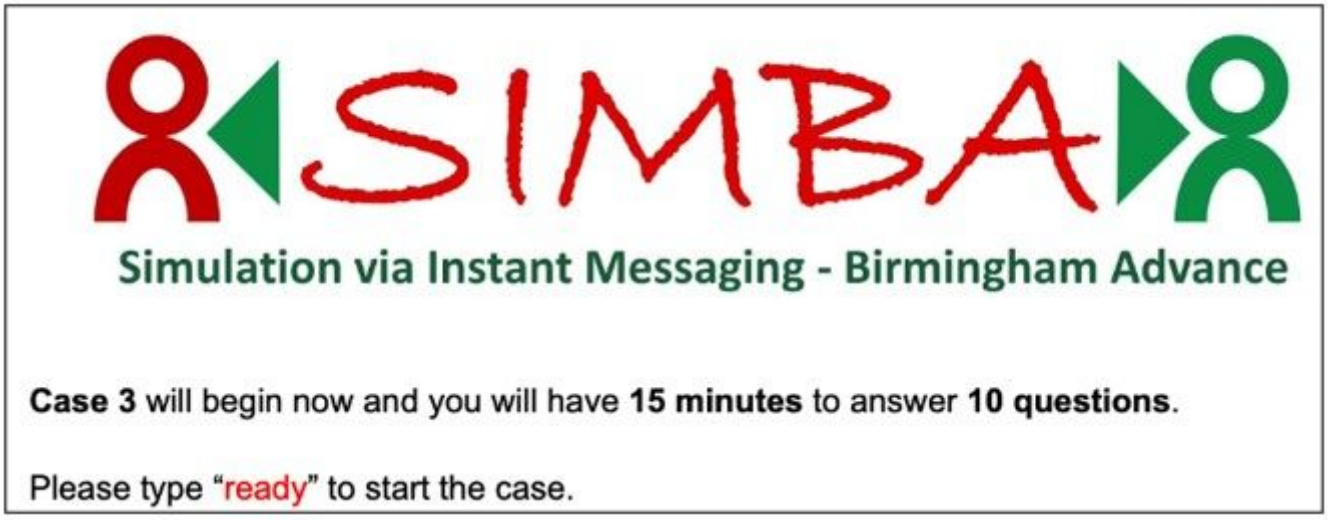

Figure 4

image sent by moderator to participant to indicate initiation of case scenario

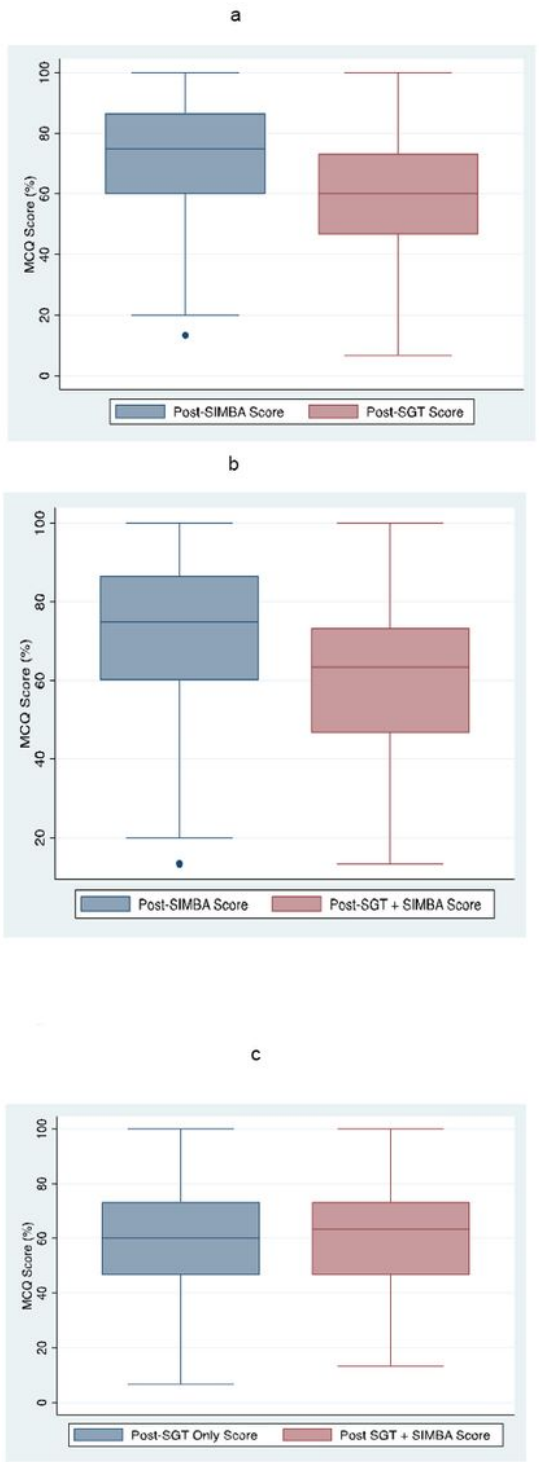

Figure 5

a: box and whisker diagram showing a comparison of MCQ scores between Post-SIMBA and Post-SGT only

b: box and whisker diagram showing a comparison of MCQ scores between students attending only SIMBA and those who attended both SIMBA and SGT

c: box and whisker diagram showing a comparison of MCQ scores between students who attended SGT only and those who attended both SGT and SIMBA