The simulated clinical environment

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The simulated clinical environment: Cognitive and emotional impact among undergraduates

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ABSTRACT

Context: Simulated clinical immersion (SCI) is used in undergraduate healthcare programs to expose the learner to real-life situations in authentic simulated clinical environments. For novices, the environment in which the simulation occurs can be distracting and stressful, hence potentially compromising learning.

Objectives: This study aims to determine whether SCI (with environment) imposes greater extraneous cognitive load and stress on undergraduate pharmacy students than simulated patients (SP) (without environment). It also aims to explore how features of the simulated environment influence students' perception of learning.

Methods: In this mixed-methods study, 143 undergraduate pharmacy students experienced both SCI and SP in a crossover design. After the simulations, participants rated their cognitive load and emotions. Thirty-five students met in focus groups to explore their perception of learning in simulation.

Results: Intrinsic and extraneous cognitive load and stress scores in SCI were significantly but modestly higher compared to SP. Qualitative findings reveal that the physical environment in SCI generated more stress and affected students' focus. In SP, students concentrated on clinical reasoning. SCI stimulated a focus on data collection but impeded in-depth problem solving processes.

Conclusion: The physical environment in simulation influences what and how students learn. SCI was reported as more cognitively demanding than SP. Our findings emphasize the need for the development of adapted instructional design guidelines in simulation for novices.

Introduction

Simulated clinical immersion (SCI), a simulation modality which reproduces real-life situations in an authentic simulated workplace environment, has now become an educational imperative of clinical training in health professions education (Teteris et al. 2012). However, the assumption that learning in a highly authentic clinical environment leads to better transfer of learning is debatable (Norman et al. 2012), especially for junior students (Girzadas et al. 2007; Issenberg et al. 2011). For novices, who have limited clinical experience, unfamiliar learning environments can potentially be distracting rather than add meaning to a learning task (Van Merriënboer & Sweller 2010). Current instructional design models hardly inform us on how to adapt the physical environment in simulation for undergraduate healthcare students in part because its cognitive and emotional impact remains misunderstood.

Simulation-based education provides meaningful learning opportunities for students to practice, to err, and to learn in a safe simulated environment (Ziv et al. 2003; Weller 2004; Cook et al. 2011; Cook et al. 2013). Different simulation modalities enable the alignment of task demands with the learning objectives (Chiniara et al. 2013; Hamstra et al. 2014). By design, SCI offers significant learning tasks closely connected and constantly interacting with the clinical environment, therefore reaching higher levels of the Miller's pyramid of clinical competency (Miller 1990). These learning activities are undoubtedly cognitively stimulating for novices. The type of cases presented in SCI may comprise many new elements that still have to be integrated in students' cognitive schemas, which will contribute to intrinsic cognitive load, a type of cognitive load arising from processing the content to be learned (Leppink & van den Heuvel 2015).

Practice points

- Simulated clinical immersion and simulated patients are two simulation modalities commonly used for developing clinical reasoning skills.
- The interactions with the simulated physical environment are predominant in simulated clinical immersion, making it more cognitively challenging for novice learners with limited clinical experience.
- The simulated physical environment can be a source of stress and distractions, which can generate extraneous cognitive load for juniors.
- Interactions with the physical environment affect tranquility and influence the focus of learning.
- When designing simulated clinical immersion for novices, educators should adapt both the task and the learning environment to optimize learning.

The physical environment in SCI is a double-edged knife because environmental factors might reinforce learning with the potential risk of causing stress and

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disturbance in less experienced participants (DeMaria & Levine 2013). This risk may contribute substantially to extraneous cognitive load (Leppink & van den Heuvel 2015), which is cognitive load that does not pertain to learning processes and consequently hinders rather than facilitates learning (Leppink et al. 2015). Since the combination of intrinsic and extraneous cognitive load has to respect the rather narrow limits of working memory capacity, education should be designed such that extraneous cognitive load is minimized and students are stimulated to optimally allocate their available resources to deal with the intrinsic cognitive load (Leppink et al. 2015). A recent mixed-methods study provided evidence for how it can be achieved in the context of the design of objective structured clinical examinations by changing task demands (Lafleur et al. 2015). Given the amount of human and material resources invested in the use of SCI, it is pressing to explore how novices experience this simulation modality and how it affects their learning processes (Issenberg et al. 2011).

Recent evidence suggests that emotions experienced by learners during a simulation is directly linked with the cognitive load imposed on them (Fraser et al. 2012; Fraser et al. 2014). A growing amount of data demonstrates that excessive stress and anxiety produce a negative impact on learning, whereas positive emotions – particularly emotions associated with a pleasant state of mind – can either enhance or hinder learning (Darke 1988; Sorg & Whitney 1992; Isen & Reeve 2005; Fraser et al. 2014). Stress in simulation has been associated with a positive performance, up to a certain level after which detrimental effects on performance and learning can be observed (DeMaria & Levine 2013; Fraser et al. 2014). Fraser et al. (2012) have demonstrated that increased *invigoration* and decreased *tranquility* during SCI training impose a greater cognitive load on medical students, which resulted in a poorer task performance. It is still unknown whether different simulation modalities have a different impact on emotions.

Among the different modalities, simulated patients (SP) are typically used to replicate encounters with real patients and are useful to learn history taking, physical examination, and clinical reasoning (Barrows 1993; Cleland et al. 2009). SPs are persons who have been trained to portray a patient with a specific condition in a realistic manner (Barrows 1993). As opposed to SCI, the environment in which SP simulation takes place can be in either clinical or nonclinical settings, since it is not intended to interact directly with the learning tasks (Chiniara et al. 2013). Considering the additional environmental factors inherent to SCI, we can hypothesize that this modality mobilizes more cognitive resources than SP (Maran & Glavin 2003). More specifically, cognitive load theory predicts that the increase in maneuvers and other actions elevate intrinsic cognitive load, while an increased demand on problem-solving search contributes to a higher extraneous cognitive load (Leppink et al. 2015). The purpose of this study is to determine how SCI affects cognitive load and emotions compared to less resource-intensive SP simulation.

We designed this experiment to address the following research questions: *What is the difference between SCI and SP in terms of intrinsic and extraneous cognitive load, self-perceived learning, emotions, and overall appreciation of their experience for undergraduate pharmacy students?* To understand what constituted intrinsic and extraneous cognitive load for our students and explore students' perception of learning during simulation, we studied qualitatively *how do features of the simulated physical environment influence students' perception of learning*? We hypothesize that, compared to SP, SCI increases intrinsic cognitive load (**H1**), does not increase self-perceived learning (**H2**) but rather elevates extraneous cognitive load (**H3**) and negative emotions (**H4**). Therefore, altogether, we have no reason to expect that students appreciate SCI more or less than SP (**H5**).

Method

Setting

This study was conducted from November 2014 to January 2015 at Laval University Faculty of Pharmacy (Quebec, Canada) in the Pharmacy Simulation Laboratory, which replicates a pharmacy workplace fully equipped with authentic material commonly found in community pharmacies. For instance, real medications, electronic pharmacy records, telephones, and electronic references and books are made available if required for a learning task.

Participants

Participants study in a 4-year competency-based pharmacy program (PharmD), entirely administered in French. Admission in the program is based on academic results and on psychometric test results. Participants were enrolled on a voluntary basis and had experienced four SCI and six SP activities prior to the experiment in the Pharmacy Simulation Laboratory. They were familiar with the different roles they played during the simulation. Sampling was made using cluster-randomization for the experiment. All students had prior knowledge on the targeted clinical contents of the cases.

Intervention

Participants experienced both SP and SCI in a crossover sequence (Figure 1). Based on quality features for designing simulation activities (Issenberg et al. 2005; Motola et al. 2013), both SP and SCI had the same course of events. Each simulation session started with a short briefing, followed by a case and a debriefing period. Three cases were experienced per simulation session separated by their related debriefings.

Participants played three different roles in rotation during these simulation sessions: the pharmacist, the patient (simulated patient), and the observer. When students played the patient, a role description was provided as well as a 10-min training prior to the simulation. One trained pharmacy simulation instructor conducted the simulations and the debriefing periods for both SCI and SP for all groups.

The main difference between SP and SCI in this study is the interactions with the physical environment. In SP, students had access to paper patients' file only, and telephones and medications were not available. Students therefore did not have to deliver the medication, to enter

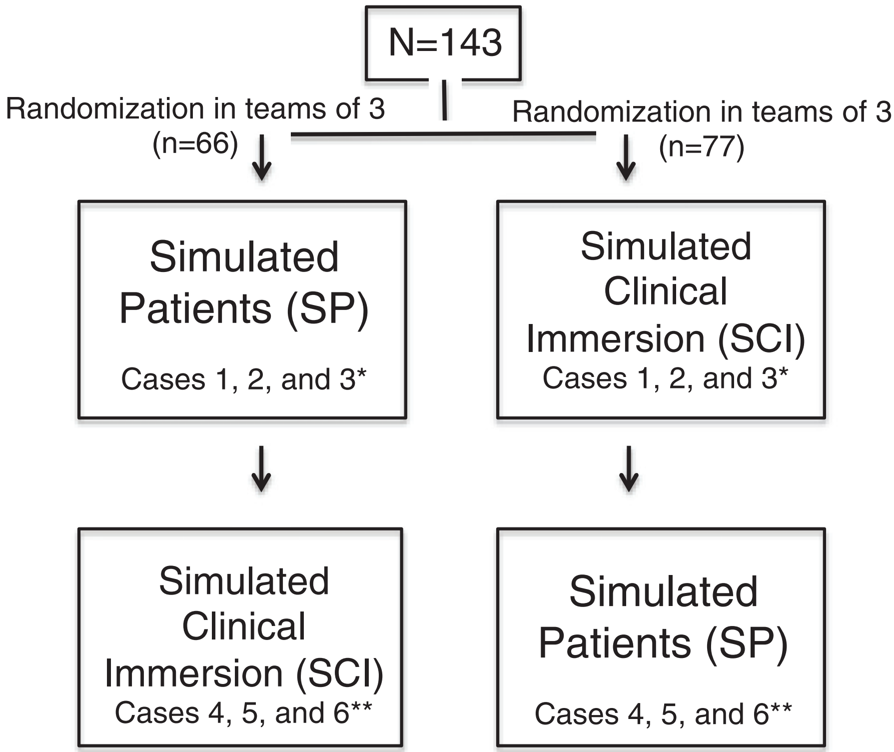

Figure 1. Randomization and experimental design.

information in patients' file, and to use the real telephone to communicate with a simulated third party (physician for example). Interactions with the physical environment were very limited in SP.

In SCI, participants had to be able to select and deliver accordingly with the legislation the appropriate drugs based on the medication in stock in their pharmacy, use the electronic pharmacy records to retrieve and enter the necessary information, and use telephones to communicate with a simulated third party if required. Interactions with the physical environment were abundant in SCI.

Quantitative data collection

Immediately after each debriefing period, participants completed a three-section questionnaire, starting with a translated version (French) of the cognitive load questionnaire developed by Leppink et al. (2014) used to measure intrinsic and extraneous cognitive load, and self-perceived learning with 11-point (0–10) rating scales (see questionnaires in Appendix 1).

The second section of the questionnaire involved rating emotions associated with the simulation using an eight-item scale containing bipolar oppositional descriptors of emotion suggested by Feldman Barrett and Russell (1998). The oppositional descriptors were tense/calm, nervous/relaxed, stressed/serene, upset/contented, sad/happy, depressed/elated, lethargic/excited, and bored/alert. Participants were asked to rate each bipolar emotion descriptor from -2 to $+2$, where positive values represent a more pleasant state of mind and negative values are associated with an undesirable mood. This instrument has been tested on medical students during simulation sessions (Fraser et al. 2012, 2014). In these studies, a factor analysis revealed two principal components. The descriptors tense/calm, nervous/relaxed, and stressed/serene were characterized as *tranquility*, whereas the remaining five represented *invigoration* (upset/contented, sad/happy, depressed/elated, lethargic/excited, and bored/alert).

In total, each participant filled out six times the questionnaires (cognitive load and emotions) – three times per session – each time immediately after the debriefing period.

Finally, once per session, participants had to rate their appreciation of both SCI and SP using 0–10 rating scales. We considered that scores of 8 and above would be excellent, 7 would be satisfactory, and 6 or below would be insufficient, meaning that simulation modality would not be of sufficient quality and would require improvement.

Quantitative analysis

Quantitative analysis was performed with IBM SPSS version 23.0 (IBM Corp., Armonk, NY). To test our five hypotheses **H1**–**H5** while accounting for the characteristics of the cross-over design and the few missing responses in the outcome variables of interest, we performed mixed-effects (multilevel) models (Leppink 2015; Leppink & van Merriënboer 2015). We specified simulation type (SCI vs. SP) and role (pharmacist, patient, observer) as fixed effects and student-level random intercepts as random effects.

Internal consistency for each scale was sufficient for the cognitive load and the emotion-rating questionnaires, and quality-assurance items. All Cronbach's alpha coefficients were above 0.7, except for extraneous cognitive load in SP for the three roles ($\alpha = 0.577$, 0.662 and 0.697).

Qualitative data collection and analyses

As part of an explanatory sequential design, 2 months after the simulation sessions, participants were convened to participate in focus groups, which were conducted by one author (M.L.T.). The purpose of collecting qualitative data was to understand what contributed to intrinsic and extraneous cognitive load for our students and explore their perception of learning during simulation. Thirty-five volunteers who had experienced the simulations were divided into six different groups using maximal variation sampling based on the correlation between differences in extraneous cognitive load and *tranquility*. Open questions were asked on students' perception of learning during SP and SCI and elements that enhance or hinder learning in simulation (see focus group questions in Appendix 2).

Focus groups were audio-recorded and transcribed integrally. The interviewer listened to the interviews and coded the content of the discussions. A second author (A.L.) listened to 50% of the interviews and validated the coding (topics, themes). In case of disagreement, discussions between the authors occurred until an agreement was reached, although no major issues arose during the analysis.

Ethical considerations

This study received approval from the Research Ethics Committee of Laval University (# 2014-217). Written informed consents were obtained prior to randomization. Participants were asked to reiterate their consent to participate to the focus groups. They were made aware that the research material would remain confidential and that performance during the simulations would not be used for assessment purposes. Investigators were not directly involved with students' training at the moment of conducting the research.

Results

Quantitative results

One hundred and seventy-four second-year undergraduate pharmacy students were invited to participate to this study. One hundred forty-three students (average age of 21.75 with a standard deviation of 2.46; 71% female) responded positively and were representative of the studied population (response rate of 82.2%).

Table 1 presents means and standard deviations for each of the outcome variables for each combination of simulation type and role. Table 2 presents the outcomes of mixed-effects analysis for each of the response variables.

In line with **H1** (intrinsic cognitive load) and **H3** (extraneous cognitive load), the presented findings indicate that intrinsic and extraneous cognitive load were on average significantly higher in SCI than in SP, and in line with **H4**, *tranquility* was on average somewhat lower in SCI as well. Further, we did not find convincing evidence against **H5** that SCI and SP are appreciated about the same. However, not in line with **H2**, the findings with regard to self-perceived learning do appear to indicate a slight preference toward SCI.

Qualitative results

The focus groups added enlightenment to the quantitative analysis by identifying, which elements of the simulation (environment and learning task) mobilized their mental efforts and how the simulated physical environment influences students' perception of learning. Data saturation was reached after three of the six focus groups.

Table 1. Means (M) and standard deviations (SD) [and sample size n] for each of the outcome variables for each combination of simulation type and role.

Condition	SP	SCI
Intrinsic cognitive load (0–10)		
Pharmacist	4.30 (2.06) [$n=143$]	4.72 (2.03) [$n=143$]
Observer	4.08 (1.71) [$n=142$]	4.28 (1.85) [$n=140$]
Patient	4.04 (1.77) [$n=142$]	4.34 (1.79) [$n=143$]
Extraneous cognitive load (0–10)		
Pharmacist	1.60 (1.59) [$n=141$]	2.95 (2.14) [$n=143$]
Observer	1.12 (1.26) [$n=141$]	1.86 (1.71) [$n=142$]
Patient	1.14 (1.16) [$n=140$]	1.69 (1.74) [$n=138$]
Self-perceived learning (0–10)		
Pharmacist	7.02 (1.76) [$n=143$]	7.43 (1.40) [$n=143$]
Observer	6.83 (1.67) [$n=140$]	7.29 (1.50) [$n=142$]
Patient	6.84 (1.65) [$n=142$]	7.02 (1.55) [$n=140$]
Tranquility[a] (−2 to +2)		
Pharmacist	0.66 (1.09) [$n=143$]	0.35 (1.15) [$n=142$]
Observer	1.41 (0.85) [$n=142$]	1.32 (0.87) [$n=143$]
Patient	1.36 (0.81) [$n=143$]	1.30 (0.88) [$n=142$]
Invigoration[b] (−2 to +2)		
Pharmacist	0.97 (0.76) [$n=143$]	0.96 (0.78) [$n=143$]
Observer	1.13 (0.75) [$n=142$]	1.16 (0.80) [$n=140$]
Patient	1.17 (0.76) [$n=143$]	1.14 (0.75) [$n=142$]
Students' appreciation (0–10)		
No distinction between roles	8.77 (1.14) [$n=142$]	8.83 (1.06) [$n=142$]

[a]Tranquility = tense/calm, nervous/relaxed, stressed/serene (items 1–3 of the emotion-rating questionnaire).
[b]Invigoration = Upset/contented, sad/happy, depressed/elated, lethargic/excited, bored/alert (items 4–8 of the emotion-rating questionnaire).

Table 2. Outcomes of mixed-effects analysis for each of the response variables.

Effect	df1, df2	F value	p Value
Intrinsic cognitive load			
Role[a]	2, 565.851	4.067	0.018
Simulation[a]	1, 142.817	5.960	0.016
Simulation *by* role[b]	2, 566.150	0.361	0.697
Extraneous cognitive load			
Role[a]	2, 554.896	44.260	<0.001
Simulation[a]	1, 140.349	48.616	<0.001
Simulation *by* role[b]	2, 555.128	8.519	<0.001
Self-perceived learning			
Role[a]	2, 560.984	4.769	0.009
Simulation[a]	1, 141.493	11.233	0.001
Simulation *by* role[b]	2, 560.775	0.850	0.428
Tranquility			
Role[a]	2, 565.621	122.761	<0.001
Simulation[a]	1, 141.761	6.115	0.015
Simulation *by* role[b]	2, 565.624	2.480	0.085
Invigoration			
Role[a]	2, 563.933	14.017	<0.001
Simulation[a]	1, 142.111	0.012	0.913
Simulation *by* role[b]	2, 563.928	0.293	0.746
Students' appreciation			
Simulation[a]	1, 708.986	2.780	0.096

[a]Main effect.
[b]Interaction effect.

Students learn clinical reasoning in SP

Although all cases were designed to develop clinical reasoning, students confirm their deeper engagement in clinical reasoning during SP because they felt that they had more time to focus on the clinical cases rather than on technical aspects of the environment. They also felt that they could interact more with their simulated patient during SP.

> In SP, we develop more our clinical judgement. I felt we had more time to think and practice our counselling. (P431)

Students practice data collection in SCI

Students admitted not to engage as deeply in problem solving in SCI, because they essentially focus on data collection. They invested considerably more mental effort in locating and collecting information from the patient's authentic computer file, which distracted them from actually solving the problem once recognized. In the end, SCI helps novices develop autonomy with technical skills rather than engaging in deep problem solving.

> In SCI, we develop strategies to collect information and analyse the patient's file. (P213)

The physical environment of SCI was considered stressful and probably hinders learning

Most students reported the physical environment, but not all aspects of it, as stressful. They mention that the environment mobilizes mental effort in SCI. For example, accessing and consulting the patient's electronic pharmacy records was more demanding for most students compared to paper files. Consequently, students have less time for experiencing the rest of the case, if they even finish it, which adds to performance anxiety. Even though they are familiar with software and common pharmaceutical websites, all students do not refer to them effortlessly. Having access to telephones and medications was less stressful and did not seem to influence students' perception of learning.

> I learned more in SP, because in SCI, there were too many things to consider at the same time, it was just too much. (P601)

> I am more stressed in SCI. I try to think, but when I am stressed, I just don't compute! (P151)

Performance anxiety is inherent, even in the absence of formal assessment

Students reported that being observed by peers and teachers while playing the pharmacist contributes to the stress of performance. Other roles in the simulation, such as the patient and the observer, are not associated with performance anxiety. Performance anxiety was present in both SP and SCI even though the simulations were presented as learning activities and did not comprise any formal assessment of performance.

> The fact that we are being observed or filmed is stressing [in both SP and SCI]. I don't perform well when I am feeling evaluated. But I don't know if the fact that I did not perform well hinders my learning, maybe … (P111)

Discussion

This study helps to understand how the simulated physical environment influences students' perception of learning in simulation. Students reported on average higher intrinsic and extraneous cognitive load scores and slightly more negative emotions in SCI compared to SP, as well as a somewhat higher self-perceived learning score. These results confirm our hypothesis that SCI is more cognitively challenging for novices, because it requires them to be able to deal with more information at the same time. In terms of task complexity, which is mainly determined by the degree to which elements within the task interact and by the number of interactions with the environment (Van Merriënboer & Sweller 2010; Choi et al. 2014), SCI is unsurprisingly perceived as slightly more complex since students had to perform additional technical steps (e.g. preparing the medication, entering information in the patient's file, use the real telephones to communicate with the physician if needed) that resulted from interactions between the task and the environment. Nevertheless, the principal learning objectives both in SP and SCI aimed at developing clinical reasoning and problem-solving skills in various clinical situations, although in SCI, students incidentally developed technical and administrative sub-skills associated with the primary tasks. Our qualitative findings indicate that the interactions with the physical environment can influence the very nature of what students learn (data collection only in SCI and problem-solving in SP), even though we did not intend it. To our knowledge, this is the first study that highlights the impact of the physical environment in simulation on students' perception of learning. Immersing junior pharmacy students in a highly authentic clinical environment can potentially lead to a shift of focus and prevent them from learning what they should have learned. Others studies are needed to confirm whether this effect is also observed in other healthcare disciplines. Both SP and SCI are powerful educational tools for skills training, but extraneous cognitive load arising from the physical environment should not be underestimated when selecting a simulation modality to match with the learning objectives (Choi et al. 2014; Hamstra et al. 2014).

Our quantitative and qualitative results show that students experience stress and performance anxiety in SCI, but also in SP. In our study, simulations were designed to minimize sources of stress by avoiding performance assessment and unfamiliar environments. Although students described being observed by peers and videotaped as stressful, these aspects are very common features of simulation activities used to facilitate feedback and debriefing (Fanning & Gaba 2007) and to encourage deliberate practice (Issenberg et al. 2005). By nature, simulation engenders stress and extraneous cognitive load, even with our best effort to put our students in a comfortable and safe learning environment (LeBlanc et al. 2014). Emotions experienced during simulations are proven to affect a variety of cognitive processes in short or long-term, such as decision-making, attention, and memory (LeBlanc 2009; LeBlanc et al. 2014). For example, recent evidence suggests that exposing medical students to deteriorating cases in simulation engenders more stress and leads to negative short-term learning outcomes (Fraser et al. 2014). Our study focused only on the immediate effect of simulation, which showed that small environmental changes affect *tranquility* and influence the focus of learning (problem solving vs. data collection). We are, however, lacking of evidence with regards to long-term retention of information learned in stressful simulations in health professions education.

In our study, differences between SCI and SP in average intrinsic and extraneous cognitive load were on the proximal end of the scale. Although this may indicate that – for learners comparable to the participants in the current study

– SP and SCI are not that different in terms of cognitive load, it might also reflect to some extent that cognitive load research thus far has not really considered the effect of the physical environment on the learner's perception of the learning task (Choi et al. 2014). A recent systematic review on the validity of cognitive load measures in simulation-based education demonstrated that, although cognitive load theory is an interesting framework for instructional design in healthcare simulation training, current tools to measure cognitive load seem to engender inconsistent correlations between cognitive load and learning outcomes in the context of simulation (Naismith & Cavalcanti 2015). These findings can partially explain why our quantitative findings indicate a rather modest difference between the modalities and why our qualitative findings are more polarized. We believe that current cognitive load questionnaires do not fully grasp the sources of extraneous cognitive load in simulation, revealing the need for the development of adapted tools to adequately measure the components of cognitive load in simulation (Haji et al. 2015; Naismith et al. 2015).

Conclusion

Simulation-based education offers meaningful learning opportunities for undergraduate healthcare students without compromising patients' safety, but emotions experienced during the simulation and the environment in which it takes place will impact what and how students learn. Regulating the simulated physical environment changes how students attend to learning objectives, emphasizing educators' role in designing simulation tasks and environments adapted to the learners' needs (Sandars et al. 2015).

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Disclosure statement

The authors report no conflicts of interest. The authors alone are responsible for the content and writing this article.

Glossary

Simulated Clinical Immersion: Simulated clinical immersion is a simulation modality reproducing real-life situations in an authentic simulated workplace environment. It may comprise simulated patients and/or simulators if required within the simulation scenario. This simulation modality is typically used to develop clinical reasoning skills and team training.

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Appendix 1

Questionnaires

Part I: Cognitive load questionnaire by Leppink et al. (2014)

All of the following questions refer to the *case-debriefing* that just finished. Please take your time to read each of the questions carefully and respond to each of them on a scale from 0 to 10, in which "0" means not at all and "10" means completely the case.

1. The content of this activity was very complex.
2. The problems covered in this activity were very complex.
3. In this activity, very complex terms were mentioned.
4. I invested a very high mental effort in the complexity of this activity.
5. The explanations and instructions in this activity were very unclear.
6. The explanations and instructions in this activity were full of unclear language.
7. The explanations and instructions in this activity were, in terms of learning, very ineffective.
8. I invested a very high mental effort in unclear and ineffective explanations and instructions in this activity.
9. This activity really enhanced my understanding of the content that was covered.
10. This activity really enhanced my understanding of the problems that were covered.
11. This activity really enhanced my knowledge of the terms that were mentioned.
12. This activity really enhanced my knowledge and understanding of how to deal with the problems covered.
13. I invested a very high mental effort during this activity in enhancing my knowledge and understanding.

Questions 1–4 are meant to evaluate intrinsic cognitive load, and questions 5–8 estimate extraneous cognitive load. Questions 9–13 reflect self-perceived learning (former "germane cognitive load").

Part II: Emotion-rating questionnaire Bipolar oppositional descriptors of emotion as suggested by Feldman et al. (1998)

The following items confront two opposite emotions. While referring to the *case-debriefing* period that just finished, please take your time to read each items and rate from −2 to 2 the emotions you felt, where a negative value is associated with an undesirable experience and a positive value is associated with a more pleasant experience.

1. Tense (−)/calm (+)
2. Nervous (−)/relaxed (+)
3. Stressed (−)/serene (+)
4. Upset (−)/contented (+)
5. Sad (−)/happy (+)
6. Depressed (−)/elated (+)
7. Lethargic (−)/excited (+)
8. Bored (−)/Alert (+)

Items 1–3 are intended to evaluate Tranquility, whereas items 4–8 measure Invigoration, as suggested by Fraser et al. (2012).

Part III: Quality assurance questions Inspired by the quality features from *Issenberg et al. (2005)*

All of the following questions refer to the *case-debriefing* that just finished. Please take your time to read each of the questions carefully and respond to them on a scale from 0 to 10, in which "0" means not at all and "10" means completely the case.

1. The case reflects a real-life situation.
2. The case was in line with the prior content in our program.
3. The debriefing period helped me understand or reinforce my understanding of the problem solving reasoning steps.
4. I had the opportunity, if needed, to ask questions and/or get answers to my questions by peers or by the instructor.
5. I learned a lot during this activity (case and debriefing).
6. I feel more confident to deal with a similar situation in real life in the future.

Appendix 2

Focus group questions

The following questions were asked during the focus group interviews.

- What is your general impression of the two simulation sessions you have experienced? Did you notice something different? Why?
- Are you under the impression that you have learned more in one modality? Why?
- Which aspects of the simulation do you consider hinder or enhance your learning? Why? (In specific physical environment, content of the cases, organization of the simulation, etc.)
- What are the essential conditions for you to learn in simulation?
- What are the impacts of simulation on learning from your perspective?