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Research Paper

An open randomized controlled study comparing an online text-based scenario and a serious game by Belgian and Swiss pharmacy students

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ABSTRACT

Introduction: To compare online learning tools, looped, branch serious game (SG) and linear text-based scenario (TBS), among a sample of Belgian and Swiss pharmacy students.
Methods: Open randomized controlled study. The lesson was based on the case of a benign cough in a healthy child. A randomized sample of 117 students: only the Swiss students had attended a previous lecture on coughs. Participation rate, pre- and post-experience Likert scales and students' clinical knowledge were measured.
Results: Our primary hypothesis was demonstrated: students favored the SG even if navigation was rated as more complex, and students who performed the SG better understood the aim of pharmacist triage in case of cough. The influence of the SG appeared to be linked to the presence of a previous lecture in the curriculum.
Discussion and conclusion: SG and TBS are effective to teach pharmacist triage. Higher SG complexity should be used to teach the aim of pharmacist triage in the case of a specific disease and could be an alternative to simulated patients. A simpler TBS does not require a previous lecture and a debriefing to be fully effective.

Introduction

Serious games (SG) have proven to be valuable tools for pharmacy education; they aim to actively teach students by forcing them to make decisions in contexts that are close to "real life" situations in a protected environment.[1] According to Zyda,[2] a digital SG can be defined as "a mental contest, played with a computer in accordance with specific rules, that uses entertainment, to further government or corporate training, education, health, public policy, and strategic communication objectives". The Université Libre de Bruxelles (Brussels, Belgium) and the University of Geneva (Switzerland) were interested in integrating these tools in the second year master of the pharmacy students' curricula. In both countries, this corresponds to their fifth and last academic year, which consists of lectures and several months of internship in community and in hospital pharmacies. Students in both universities are trained in

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classrooms with simulated patients (i.e., a method "in which actors play the role of patients"[3]) to be prepared to interact with patients. Pharmacist triage and self-care with non-prescription products (called "pharmacist triage" in this article) are specifically taught and must be practiced during their internship. This is the major role of pharmacists with non-prescription products, whereby they assist patients' self-care and triage patients.[4] However, a step is probably missing between the lectures and the training with simulated patients. We experienced that some students are not fully prepared to conduct the patient interview or engage in clinical reasoning. The use of virtual patients in online training (i.e., "a simulated patient, typically generated by a computer software program, and used to simulate realistic clinical scenarios"[3]) was considered as an option to prepare students to interact with simulated patients. Indeed, as mentioned by Jabbur-Lopes et al.,[3] the use of virtual patients "allow[*s*] students to adopt the role of a health care provider in a safe environment where they can develop clinical and communication skills."

Previous studies have shown that students positively evaluated SGs as a "dynamic virtual patient platform that incorporated a branched-narrative, decision-making teaching model," when they only tested such a learning tool.[5] Text-based online methods that feature virtual patients can also be an option, and they are simpler to develop. However, there are few studies that compare SG with traditional simpler text-based methods.[6,7] Hence, we were interested in comparing an SG with a text-based scenario (TBS) to evaluate whether the development of an SG is worth the effort. In addition, most of the previous studies on such learning tools have been performed outside of Europe.[3,8–10] We sought to compare two online training lessons that simulate a case of pharmacist triage (a linear text-based scenario and the type of looped, branch-learning simulation that is integrated in an SG) with students who follow Belgian and Swiss curricula.

Our primary hypothesis was that students would favor an SG compared to a TBS and show a better understanding of pharmacist triage in case of a cough after the SG. Our secondary hypothesis was that Swiss students would better evaluate the SG and the TBS and show a better understanding of pharmacist triage in case of a cough after the SG and the TBS. Indeed, the SG being non-linear is more complex to realize, and the Swiss students had attended a mandatory two-hour lecture on pharmacist triage in a case of infection of the upper respiratory tract (including cough) three months before the study, while the Belgian students did not have a specific lecture on this topic before the study. Our primary objective was to determine whether participation rate and students' post-experiment statements and knowledge were higher in the SG group compared to the TBS group. Our secondary objective was to determine whether differences were observed between the four subgroups (Belgian students – called "no prior lecture students" - in the TBS and SG groups and Swiss students - called "prior lecture students" - in the TBS and SG groups) by exploring their results related to post-experiment statements and knowledge.

Methods

This study was determined to be exempt from board approval by both institutions, in accordance with Belgian and Swiss laws. This was an open double-center, randomized, parallel-group design study that was conducted in French in two universities: one in Brussels (Belgium) and one in Geneva (Switzerland). It was designed to compare pre- and post-experience knowledge and the statements of: 1. students who performed one of the following online lessons: a looped, branch SG vs. a linear TBS and 2. "no prior lecture students" (Belgian students with no previous lecture on triage in case of infection of the upper respiratory tract) vs. "prior lecture students" (Swiss students with previous lecture on triage in case of infection of the upper respiratory tract). Each student was considered to be eligible (no exclusion criterion) and was invited by e-mail (followed by two reminders) to take part on a voluntary basis. They were informed that the results would be anonymously treated and that no one who was involved in their teaching or exams would have access to their participation status or the results. There were 117 participants from among pharmacy students in the second master year, including Belgian (71 / 60.7%) and Swiss (46 / 39.3%) students. To obtain two comparable groups, the students were randomized (Microsoft Excel™ 2007) according to gender and university stratification. Gender was used for stratification because there were more women in both classrooms and because men are more involved in gaming in Europe.[11]

The TBS, access to lessons and questionnaires were generated by a secured learning management system, Moodle™ 2.6.2+ in Belgium and 2.7.2 in Switzerland. This secured learning management system was chosen because both universities used it to give students access to lectures and documents. The SG was developed using an authoring tool (ITyStudio™ 2.6 - A licence of this software costs $350 / year. Prices are available on the website of the company: https://itystudio.com/pricing/) that allows for the simulation of a community pharmacy scenario in 3D: a patient and a pharmacist interact in a community pharmacy environment (Fig. 1). This software, which is compatible with Moodle™, allows for the choosing of avatars, movements and attitudes. These are part of a variety of clickable options (e.g., pre-formatted emotions such as anger, nervousness, and spite). The voice element had to be recorded. The construction of a scenario was based on a map with loops and branches to show each scene that related to the interactive training experience. This software was chosen because no special competencies in information technologies were required for its use. In the present case, the student who developed the SG had no previous experience with similar software. She spent two days practicing with tutorials before developing the SG. This allowed overcoming one of the main barriers to developing an SG and demonstrated that pharmacists can directly develop scenarios.[6]

During the study, the students in both countries were geographically dispersed for their internship: they did not meet to attend lectures. They were asked to refrain from talking about the study or the online lesson and to refrain from sharing their access to Moodle™. Both arms of the study were conducted outside of faculty computer laboratories (e.g., at the students' homes) to replicate the real conditions of use that are planned for such online training. Links to instructions and tutorials on the secured learning management system were sent by e-mail, and e-mail assistance was offered for technical support. Students had access from January 16th, 2015, to February 1st, 2015, to complete the full track of the study that was determined on Moodle™, which included the following steps: 1. sociodemographic data; 2. pre-experience data; 3. lesson (SG or TBS); 4. clinical knowledge test; 5. post-experience

Fig. 1. Screenshot of the community pharmacy environment with possible choices to explore red flags presented by the child (translated from French): the father's avatar asked "*Should I worry about any sign in my child?*" The students had to choose the correct questions to check with regard to red flags. Each time the pharmacist's avatar asked about a red flag, the father's avatar gave the answer (e.g., "*Does he have a fever?*" and "*No, my wife checked it this morning.*").

data, and 6. assessment of the learning tool. Each step had to be fully completed before a student could move to the next one; it was possible to take a break in the track between each step. For the purpose of the study, the lesson was available only once.

The case that was used for the online lesson was based on the protocol of a 2014 mystery shopping test of a Swiss consumer association that evaluated the quality of pharmacist triage: a man asks for cough syrup to treat a benign cough in a healthy two-year old child.[12] This syrup is contraindicated for a child of that age. The scenario (algorithm and red flags) was based on a reference textbook that was used in a community pharmacy internship in Switzerland.[13] The pharmacist was required to perform an adequate triage (e.g., to exclude red flags), to deliver an appropriate medicine (or to explain that no medicine was required) and to give sufficient advice (e.g., to increase fluid intake). This protocol was chosen because it reflects a common case that is encountered in "real life." In addition, in the consumer association test, 10 pharmacies out of 24 delivered contraindicated products. Consequently, this case was considered to be sufficiently challenging to motivate students.

Both of the learning environments (SG and TBS) provided similar feedback and allowed the students to meet the same learning objectives, regardless of the chosen path. In the TBS, students followed a linear and identical path whatever their answers. They directly received feedback before moving to the next step. In the SG, students followed different paths depending on their answers. These paths were organized as loops and branches so that all students eventually went through the same steps (including feedback), but in a different chronology. The learning objectives include the following: 1. to apply the general principles of pharmacist triage; 2. to evaluate the nature of a cough and the associated symptoms; 3. to analyze whether red flags are present in a child having a cough; 4. to analyze the pros and cons of the various available cough treatments, and 5. to understand and apply the current recommendations that are related to cough treatment in a child. In the TBS, students were required to choose one or several correct answers at each step, which corresponded to the questions that they would have asked or the actions that they would have performed. The information that was needed to solve the case (e.g., child's age or allergies) was indicated in the feedback. In the SG, the questions that they were required to ask or the actions that they were required to perform were split into several steps to simulate an interview. The information that was needed to solve the case was given by the father's avatar, who answered the pharmacist avatar's questions. For example, to learn about red flags in the case of a cough in a child, the students were asked to tick correct answers in the TBS to answer the question "*The father says that he may have missed an important symptom in his child. He asks you which symptoms he should worry about?*" Feedback was provided on the chosen red flags to explain which ones were correct. In addition, the absence of any red flags in the child was indicated in the feedback: in this case, dialog was suggested, and each student had to imagine it. In the SG, the father's avatar asked "*Should I worry about any sign in my child?*" The students had to choose the correct questions to check with regard to red flags. Each time the pharmacist's avatar asked about a red flag, the father's avatar gave the answer: e.g., "*Does he have a fever?*" and "*No, my wife checked it this morning.*" When the students estimated that they had checked each required red flag, they chose to move to the next step. Then, they received feedback on the chosen red flags, to learn which ones were correct.

Before each online lesson, statements (eight questions) were submitted to students to ensure that both of the groups of participating students were comparable in terms of sociodemographics. The students' experience with both learning tools (SG or TBS) was assessed by pre- and post-experience Likert scale measurements with two questionnaires, which included statements that were scored with 1. " I totally disagree"; 2. "I disagree"; 3. "I partially disagree", 4. "I partially agree", 5. "I agree", or 6. " I totally agree" (the option "I do not know" was also available). The first questionnaire explored the students' opinions on pharmacist triage based on the

three domains of the theory of planned behavior: Four questions were asked about attitude (how they considered pharmacist triage); seven questions were asked about perceived control (how they perceived their ability to perform pharmacist triage), and three questions were asked about subjective norms (how they believed they were expected to perform pharmacist triage).[14] This approach was adapted from a previous study that assessed opinions on medication therapy management by pharmacists and pharmacy students.[15] In the second questionnaire, the students were asked to rate 10 statements regarding the skills and knowledge required to triage cough in a community pharmacy. The approach was adapted from a study that assessed community pharmacists' skills and knowledge regarding the provision of opioid substitution therapy.[16] In both of the questionnaires, the results were considered for each statement. To minimize inter-individual variability, the pre- and post-test scores and the mean difference between pre- and post-test scores were compared instead of the scores between both groups.

The student's opinions on both of the learning tools were compared by a post-experience Likert scale measurement (14 questions) that was adapted from previous studies that explored the use of online lessons by pharmacists or pharmacy students.[9,17] To minimize the halo effect (in which subjects tend to respond favorably to questions if their overall opinion is favorable, and vice versa), as many favorable and unfavorable statements were submitted that address a similar theme.

To compare the influence of both online lessons on the students' learning, 11 questions were submitted to measure the students' clinical knowledge. We chose not to measure the students' clinical knowledge at the beginning of the study to avoid the learning that would have been induced by such a questionnaire.

The data were extracted from Moodle™ and anonymized on Excel™ 2007. STATA™ 13.1 was used for statistical analysis to compare both of the groups (SG vs. TBS) and the subgroups (no prior lecture vs. prior lecture). Only the data from students who completed the full study were considered. To compare sociodemographic data, a Fisher test (nominal data category with less than five values), a Pearson's chi-squared test (nominal data category with more than five values), and a Kruskal-Wallis test (to compare ages) were performed. A Mann-Whitney is considered as suitable for ordinal data and was applied to compare the answers that were given between groups or subgroups: for the mean pre-test score, the mean difference between pre- and post-test scores, and for the evaluation of the two examined learning tools, SG vs TBS and no prior lecture vs prior lecture by group (SG or TBS).[18] In addition, a Wilcoxon signed-rank test was applied in each group (SG or TBS) or subgroup (Belgian "no prior lecture students" in the SG group or in the TBS group and Swiss "prior lecture students" in the SG group or in the TBS group) to compare the two sets of data that were collected at different times. To compare the clinical knowledge scores, a Kruskal-Wallis test was applied to the mean results that were obtained by the groups and the subgroups. The results were considered to be significant if the p value ≤ 0.05.

Results

Linear TBS group vs looped, branch SG group

Among the 117 students, 70 (59.8%) completed the entire study: 69.5% of the students in the SG group and 50.0% in the TBS group (Fig. 2). The sociodemographic data of both groups of students who completed the full study were compared: no significant difference was observed (Table 1). The pre-experience statements on the theory of planned behavior did not show any difference between both groups (results not shown).

The mean difference between the pre- and post-test scores on the theory of planned behavior in each group only showed a difference ($p = 0.02$) for the statement "pharmacist triage is a good way to manage patients' health problems": changes in scores in the TBS group led to an increase, 0.5 (standard deviation (SD) 1.3), while no difference was observed in the SG group, 0.0 (SD 0.8).

In the comparison of the pre- and post-test scores in the three domains of the theory of planned behavior, five statements (No 3, 4, 5, 7, and 10) showed an increase in the TBS group, and two showed an increase in the SG group (No 8 and 10). It is interesting to note that in both groups, an increase was observed in the confidence in abilities to lead an adequate triage even in complex situations (Table 2).

Regarding skills and knowledge to triage (Table 3; the mean pre-test score and the mean difference between pre- and post-test scores are not shown because no difference was observed), three statements (No 16, 19, and 20) showed an increase in both of the groups, and one showed a decrease (No 18), which was expected. This last question suggested that cough should be treated by medicines with proven efficacy, while no medicine has a proven efficacy.[19] Statement No 17, which concerned the understanding of the aim to manage a case of cough, only showed a significant increase in the SG group.

The two examined learning tools were positively evaluated overall (results not shown). A difference was observed for two statements. Students in the SG group found it more difficult to logically navigate in the case, with scores of 3.3 (SD 1.7) in the SG group and 2.4 (SD 1.6) in the TBS group ($p = 0.03$). They also more often felt that it did not simulate a real situation, with scores of 2.4 (SD 1.5) in the SG group and 1.8 (SD 1.1) in the TBS group ($p = 0.05$).

No difference was observed in the clinical knowledge scores, with scores of 7.07 (SD 1.50) for the SG group and 6.81 (SD 1.10) for the TBS group ($p = 0.27$).

"No prior lecture students" vs "prior lecture students"

Among the 70 students who fully completed the study, 38.6% were Swiss "prior lecture students" (15/41 or 36.6% in the SG group and 12/29 or 41.4% in the TBS group), and 61.4% were Belgian "no prior lecture students" (26/41 or 63.4% in the SG group and 17/29 or 58.6% in the TBS group). The sociodemographic data of the "prior lecture students" and "no prior lecture students" who completed the full study did not show any difference (results not shown).

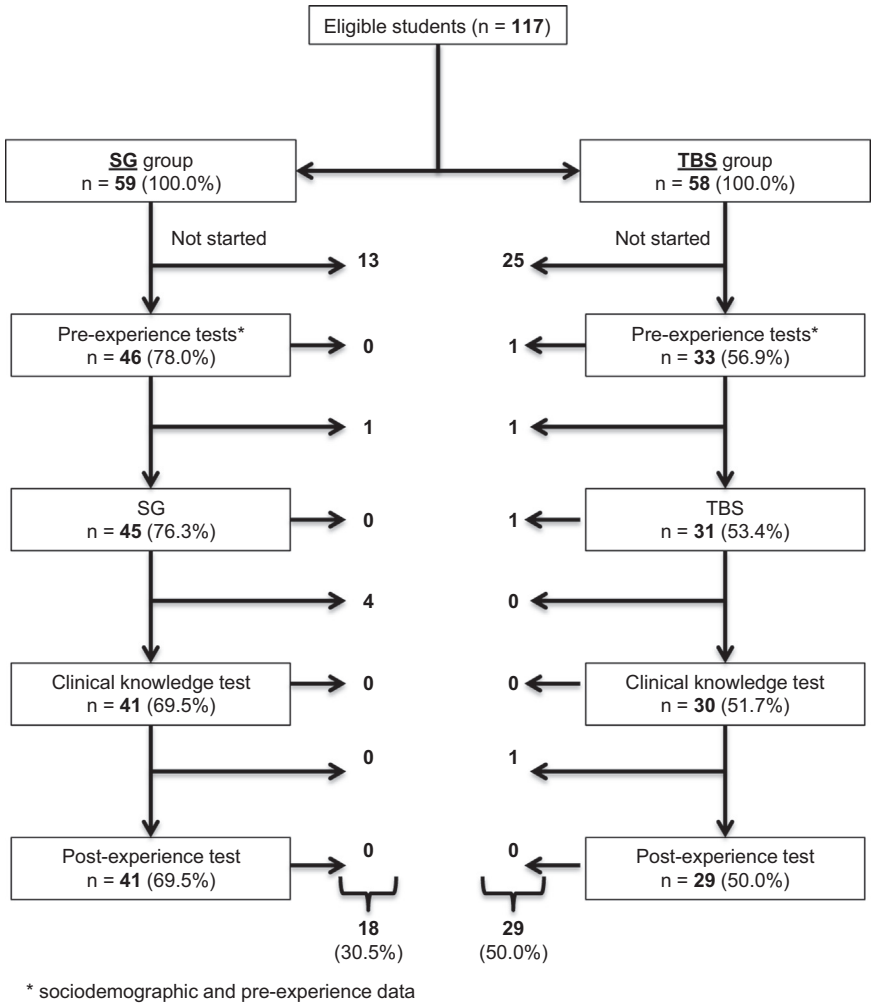

Fig. 2. Number of students (and percentage) that started, continued or finished the study in the serious game (SG) and text-based scenario (TBS) groups.

The pre-experience statements on the theory of planned behavior showed that the "prior lecture students" had a more positive attitude related to pharmacist triage: they showed a higher score for statements No 2 (5.6 (0.6) for the "prior lecture students" vs. 4.4 (1.3) for the "no prior lecture students", $p = 0.00$) and 3 (5.8 (0.4) for the "prior lecture students" vs. 5.0 (1.2) for the "no prior lecture students", $p = 0.00$). Pre-test scores related to the theory of planned behavior are not presented in Table 4 because no other difference was observed.

With regard to the mean differences of the changes in the three domains of the theory of planned behavior, a difference was shown only in the TBS group for two statements (No 3 and 9; $p = 0.05$ for both; mean differences of the changes in the three domains of the theory of planned behavior are not presented in Table 4 because no other difference was observed). In both cases, the "no prior lecture students" showed a higher increase in scores: respectively 0.9 (SD 1.6) and 0.6 (SD 1.4) for the "no prior lecture students" vs. 0.1 (SD 0.5) and −0.3 (SD 0.8) for the "prior lecture students".

When comparing pre- and post-test scores, only the "no prior lecture students" in the TBS group showed changes in attitude. They also showed a single change in perceived control. The "prior lecture students" only showed changes in perceived control whatever the learning tool; the "no prior lecture students" in the SG group only showed a difference for a single statement, related to subjective norms (Table 4).

The pre-experience statements on skills and knowledge to triage showed that the "prior lecture students" seemed to consider that they had a better understanding of the purpose of pharmacist triage in the case of a cough before the study (statement No 17: 5.4 (0.8) for the "prior lecture students" vs. 4.9 (1.2) for the "no prior lecture students", $p = 0.05$; other pre-test scores related to skills and knowledge to triage are not shown in Table 5 because no difference was observed). After the online lesson, a decrease of −0.4 (SD 0.5) was observed for the "prior lecture students" in the SG group for the statement No22: they felt less able to answer patients' questions regarding a cough. An increase of 0.5 (SD 1.1) was observed for the "no prior lecture students" in the SG group (this showed a difference between pre- and post-test scores with the "prior lecture students"; $p = 0.00$). Another mean difference ($p = 0.00$) in the TBS group between pre- and post-test scores was related to statement No18 "I think that the treatment of a cough should be based on

Table 1
Sociodemographic data of students who fully completed the study in the looped, branch serious game group and in the linear text-based scenario group.

Sociodemographic data	SG group: number (%) (n = 41)	TBS group: number (%) (n = 29)	*p*
Age	25.0 ± 3.6	26.0 ± 5.8	0.51
Gender			0.81
Male	8 (19.5)	5 (17.2)	
Female	33 (80.5)	24 (82.8)	
Student			0.69
Belgian	26 (63.4)	17 (58.6)	
Swiss	15 (36.6)	12 (41.4)	
Native language			0.47
French	31 (75.6)	24 (82.8)	
Other	10 (24.4)	5 (17.2)	
Experience in pharmacist triage			0.90
Classroom lecture	1 (2.4)	0 (0)	
+ patient simulation	2 (4.9)	3 (10.3)	
+ training in a pharmacy (without supervision)	7 (17.1)	4 (13.8)	
+ training in a pharmacy (with supervision)	31 (75.6)	22 (75.9)	
Owned devices			0.76
Computer	11 (26.8)	9 (31.0)	
+ smartphone	13 (31.7)	8 (27.6)	
+ digital tablet	1 (2.4)	2 (6.9)	
+ smartphone + games console	7 (17.1)	2 (6.9)	
+ smartphone + digital tablet	6 (14.6)	6 (20.7)	
+ smartphone + digital tablet + games console	3 (7.3)	2 (6.9)	
Gaming frequency (with any device)			0.86
Never	10 (24.4)	5 (17.2)	
1 or 2 times/year	8 (19.5)	4 (13.8)	
Once/month	4 (9.8)	3 (10.3)	
4 times/month	3 (7.3)	3 (10.3)	
8 times/month	3 (7.3)	1 (3.5)	
Several times/week	6 (14.6)	9 (27.6)	
Every day	7 (17.1)	5 (17.2)	
Gaming frequency of board games[a]			0.80
Never	9 (22.5)	9 (31.0)	
1 or 2 times/year	17 (42.5)	11 (37.9)	
Once/month	11 (27.5)	6 (20.7)	
4 times/month	2 (5.0)	1 (3.5)	
8 times/month	1 (2.5)	2 (6.9)	
Several times/week	0 (0)	0 (0)	
Every day	0 (0)	0 (0)	

SG: looped, branch serious game; TBS: linear text-based scenario.
[a] One student in the SG group did not answer.

Table 2
p values (Wilcoxon signed-rank test) comparing pre- and post-test scores of the statements related to the three domains of the theory of planned behavior in the looped, branch serious game group and in the linear text based scenario group.

Domain of the TPB, based on students' statements (score from 1 " I totally disagree" to 6 " I totally agree")		SG n = 41	TBS n = 29
Attitude	No 1 "When a specific drug is requested, it is easy to ask questions to see whether further pharmacist triage should be performed".	0.56	0.57
	No 2 "My overall opinion on pharmacist triage is positive".	0.67	0.19
	No 3 "Pharmacist triage is a good way to manage patients' health problems".	0.61	**0.01**
	No 4 "Pharmacist triage abilities assist in the recognition of their skills".	0.50	**0.03**
Perceived control	No 5 "I feel comfortable enough in pharmacist triage to seek the necessary information from patients".	0.74	**0.03**
	No 6 "I feel comfortable enough to use this information to make appropriate decisions".	0.17	0.10
	No 7 "In my daily practice, I can decide when and in which situation to perform a full, partial or no pharmacist triage".	0.60	**0.01**
	No 8 "If I wish, I have the skills to implement pharmacist triage in my current or future working environment".	**0.01**	0.06
	No 9 "My current or future professional environment allows me to implement pharmacist triage".	0.93	0.32
	No 10 "I have confidence in my ability to lead an adequate pharmacist triage (structured interview), even in complex situations".	**0.03**	**0.01**
	No 11 "I have confidence in my ability to seek information or guidelines (e.g., management recommendations) to adequately handle a triage case, even in complex situations".	0.93	0.93

SG: looped, branch serious game; TBS: linear text based scenario; TPB: theory of planned behavior; bold value: $p \leq 0.05$ Results for subjective norms are not shown because no difference was observed; statements can be seen in Table 4.

Table 3
p values (Wilcoxon signed-rank test) comparing pre- and post-test scores to assess skills and knowledge required to triage cough in community pharmacy in the looped, branch serious game group and in the linear text based scenario group.

Statements (score from 1 " I totally disagree" to 6 " I totally agree")	SG n = 41	TBS n = 29
No 15 "I have a good understanding of the nature of a cough".	0.85	0.68
No 16 "I feel able to identify the alarm signs (red flags) in the case of a cough".	**0.01**	**0.01**
No 17 "I understand the purpose of pharmacist triage in the case of a cough".	**0.04**	0.28
No 18 "I think that the treatment of a cough should be based on the use of medicines with clearly proven efficacy".	**0.00**	**0.00**
No 19 "I think it is possible to adequately treat a cough without delivering medicines".	**0.00**	**0.00**
No 20 "I think the delivery of a medicine without proven efficacy but without risk can be part of the treatment of a cough (e.g., for placebo effect)".	**0.01**	**0.01**
No 21 "I have confidence in my ability to adequately manage a cough".	0.74	0.34
No 22 "I feel able to answer patients' questions about coughing".	0.78	0.58
No 23 "I feel able to perform pharmacist triage in the case of a cough so that the patient understands the purpose of my approach".	0.80	0.12
No 24 "I feel comfortable referring a patient to a physician if it is necessary in the case of a cough".	0.45	0.98

SG: looped, branch serious game; TBS: linear text based scenario; bold value: $p \leq 0.05$ Mean pre-test score and mean difference between pre- and post-test scores are not shown because no difference was observed.

Table 4
p values (Wilcoxon signed-rank test) comparing pre- and post-test scores of the statements related to the three domains of the theory of planned behavior for "prior lecture students" and "no prior lecture students".

Domain of the theory of planned behavior, based on students' statements (score from 1 "I totally disagree" to 6 "I totally agree")		SG group		TBS group	
		NP n = 26	P n = 15	NP n = 17	P n = 12
Attitude	No 1 "When a specific drug is requested, it is easy to ask questions to see if further pharmacist triage should be performed".	0.85	0.37	0.26	0.62
	No 2 "My overall opinion on pharmacist triage is positive".	0.40	0.62	0.22	0.56
	No 3 "Pharmacist triage is a good way to manage patients' health problems".	0.94	0.32	**0.02**	0.56
	No 4 "Pharmacist triage abilities assist in the recognition of their skills".	0.24	0.77	**0.05**	0.32
Perceived control	No 5 "I feel comfortable enough in pharmacist triage to seek the necessary information from patients".	0.99	0.72	0.23	**0.05**
	No 6 "I feel comfortable enough to use this information to make appropriate decisions".	0.45	0.16	0.60	**0.03**
	No 7 "In my daily practice, I can decide when and in which situation to perform a full, partial or no pharmacist triage".	0.77	0.77	0.09	**0.03**
	No 8 "If I wish, I have the skills to implement pharmacist triage in my current or future working environment".	0.29	**0.02**	0.14	0.26
	No 9 "My current or future professional environment allows me to implement pharmacist triage".	0.49	0.38	0.12	0.30
	No 10 "I have confidence in my ability to lead an adequate pharmacist triage (structured interview), even in complex situations".	0.31	**0.03**	**0.02**	0.09
	No 11 "I have confidence in my ability to seek information or guidelines (e.g., management recommendations) to adequately handle a triage case, even in complex situations".	0.34	0.14	0.83	0.89
Subjective norms	No 12 "Only the best pharmacies can perform adequate pharmacist triage".	0.92	0.16	0.29	0.32
	No 13 "Patients appreciate pharmacist triage".	0.75	0.37	0.11	0.62
	No 14 "Other health professionals have a positive opinion of pharmacists performing pharmacist triage".	**0.05**	1.00	0.83	0.41

SG: looped, branch serious game; TBS: linear text based scenario; P: "prior lecture students"; NP: "no prior lecture students"; bold value: $p \leq 0.05$.

the use of medicines with clearly proven efficacy". As expected, a decrease was observed here: −1.9 (SD 1.3) for the "prior lecture students" and −0.2 (SD 1.6) for the "no prior lecture students".

The largest impact on skills and knowledge to triage was shown for "prior lecture students" (four significant differences in the TBS group and three in the SG group, compared to respectively one and two for "no prior lecture students"). An influence was shown in every subgroup for statement No19 only. "No prior lecture students" in the TBS group showed the smallest impact with only a change for this statement (Table 5).

Each difference observed in the evaluation of the learning tools (Table 6; three statements a, g, and k in the SG group and five statements a, b, c, k, and n in the TBS group) showed a more positive evaluation from the "prior lecture students". For example, they found the content of the case clearer in the TBS and in the SG (statement a), and they preferred to solve the case in the TBS and in the SG (statement k).

The mean clinical knowledge scores did not show any difference between "prior lecture students" and "no prior lecture students" (results not shown).

Table 5
p values (Wilcoxon signed-rank test) comparing pre- and post-test scores to assess skills and knowledge required to triage cough in community pharmacy for "prior lecture students" and"no prior lecture students".

Statements (score from 1 " I totally disagree" to 6 " I totally agree")	SG group		TBS group	
	NP n = 26	P n = 15	NP n = 17	P n = 12
No 15 "I have a good understanding of the nature of a cough".	0.74	0.42	0.77	0.85
No 16 "I feel able to identify the alarm signs (red flags) in the case of a cough".	**0.00**	0.77	0.08	**0.03**
No 17 "I understand the purpose of pharmacist triage in the case of a cough".	0.06	0.30	0.68	0.08
No 18 "I think that the treatment of a cough should be based on the use of medicines with clearly proven efficacy".	0.06	**0.01**	0.37	**0.00**
No 19 "I think it is possible to adequately treat a cough without delivering medicines".	**0.00**	**0.01**	**0.02**	**0.00**
No 20 "I think the delivery of a medicine without proven efficacy, but without risk, can be part of the treatment of a cough (e.g., for placebo effect)".	0.08	0.07	0.10	**0.04**
No 21 "I have confidence in my ability to adequately manage a cough".	0.92	0.48	0.49	0.52
No 22 "I feel able to answer patients' questions about coughing".	0.06	**0.01**	0.47	1.00
No 23 "I feel able to perform pharmacist triage in the case of a cough so that the patient understands the purpose of my approach".	0.34	0.32	0.40	0.16
No 24 "I feel comfortable referring a patient to a physician if it is necessary in the case of a cough".	0.22	0.63	0.86	0.90

SG: looped, branch serious game; TBS: linear text based scenario; P: "prior lecture students"; NP: "no prior lecture students"; bold value: $p \leq 0.05$.

Table 6
Evaluation of the two examined learning tools: serious game and text base scenario for "prior lecture students" and "no prior lecture students".

Statements (score from 1 "I totally disagree" to 6 " I totally agree")	SG group (SD) [Mann-Whitney]			TBS group (SD) [Mann-Whitney]		
	NP n = 26	P n = 15	*p*	NP n = 17	P n = 12	*p*
a. "I found that the content of the case was clear".	4.3 (1.3)	5.2 (1.2)	**0.03**	3.6 (1.7)	5.3 (1.0)	**0.01**
b. "I had trouble navigating logically in the case".	3.3 (1.5)	3.5 (2.0)	0.73	3.1 (1.6)	1.5 (1.2)	**0.00**
c. "I found that the case was relevant for pharmacy practice".	5.2 (1.2)	5.5 (0.8)	0.36	4.5 (1.6)	5.8 (0.4)	**0.01**
d. "I think that the case does not simulate a real situation".	2.5 (1.5)	2.3 (1.5)	0.71	2.0 (1.2)	1.4 (0.9)	0.13
e. "I had to consult external information, such as lectures, to answer questions or to make choices".	2.4 (1.7)	2.9 (1.9)	0.45	1.7 (1.6)	2.4 (1.5)	0.06
f. "I found that the case was incomplete: I had to look for additional information after completing it".	1.8 (1.1)	1.9 (1.4)	0.99	2.5 (1.8)	1.8 (1.1)	0.28
g. "The case helped me to develop my knowledge about cough".	4.6 (1.4)	5.5 (1.2)	**0.01**	4.5 (1.8)	5.2 (1.4)	0.21
h. "After completing the case, I would have found it helpful to discuss it during a session that was led by a teacher".	4.0 (1.7)	3.7 (2.1)	0.91	3.8 (1.4)	4.7 (1.3)	0.09
i. "The case helped me to develop my knowledge about pharmacist triage".	5.0 (0.9)	5.4 (1.0)	0.15	4.3 (1.7)	5.3 (1.2)	0.06
j. "I would not recommend the use of this learning tool to other students".	2.0 (1.6)	1.6 (1.3)	0.29	2.2 (1.7)	1.3 (0.9)	0.09
k. "I liked solving this case".	4.0 (1.5)	5.2 (0.9)	**0.03**	4.2 (1.5)	5.8 (0.6)	**0.00**
l. "I prefer a session with a simulated patient in the classroom, with a teacher and other students".	2.8 (1.6)	2.8 (1.0)	0.86	3.7 (1.8)	3.0 (1.7)	0.40
m. "I prefer an online individual learning tool".	4.1 (1.5)	4.8 (1.4)	0.37	3.6 (1.4)	4.5 (1.5)	0.16
n. "I prefer an online individual learning tool that is followed by a simulated patient in the classroom, with a teacher and other students".	4.2 (1.9)	5.1 (1.5)	0.22	4.1 (1.6)	5.6 (1.0)	**0.01**

SG: looped, branch serious game; TBS: linear text based scenario; P: "prior lecture students"; NP: "no prior lecture students"; SD: standard deviation; bold value: $p \leq 0.05$.

Discussion

To our knowledge, this is the first study of online training that included an SG and was conducted in parallel in two European countries. This point is important to emphasize, as it showed that an online lesson, such as a case that was articulated around a TBS or an SG, can be introduced in different countries with only minor changes (e.g., adapting the local names of medicines), even if students follow different curricula. The results allowed good internal validity because almost 60% of the students completed the full study. In addition, even if the participation was voluntary, there was no difference between the groups and subgroups that took part in the study.

Linear TBS group vs looped, branch SG group

Once the students connected to Moodle™ to register for the study, they were able to identify the group to which they were randomized. Consequently, the higher number of participants in the SG group is probably linked to a higher interest in the testing of a learning tool that was perceived to be more innovative.

Although the students seem to be more interested in testing the SG, no preference is observed for this tool. Similarly, a previous

study showed that students still preferred other forms of learning, even if they had a positive experience with an SG.[20]

The fact that the students in the SG group find it more difficult to logically navigate the case and that it does not simulate a real situation is probably linked to the simpler binary approach of the TBS in which students do not need to manage the interview with the patient. It is more complex to navigate in the SG: students need to structure the chronology of the questions and manage the interview based on the avatar's answers. In the TBS, the students only have to answer questions, and they can freely imagine the interview with the patients based on the information they receive. A study that compared a virtual patient case with problem-based learning showed similar findings: students seemed less accustomed to a learning method that was new.[21] This higher complexity is not correlated with worse results regarding the perceived control, skills and knowledge to triage, and the clinical knowledge score. To overcome the limitation of the serious game being more difficult to navigate, an introduction to the use of this learning tool should be planned for the students. In addition, lectures and exercises on managing patient interviews should be developed.

The students in the TBS group have a more positive opinion of pharmacist triage and feel more confident and comfortable in this task after the online lesson: in the statements related to the three domains of the theory of planned behavior, an increase is observed for five statements in this group, while an increase is observed for two statements in the SG group. This is highlighted by statements related to attitude where only students in the TBS group show changes. These results can be explained by the simpler binary approach of the TBS: the students in the SG group are not as confident and comfortable after the experience, as it is more complex to navigate in the case. However, no difference is observed in the clinical knowledge scores. Therefore, the students in the SG group are not disadvantaged by this higher complexity. In addition, the SG helps them to better understand the aim to triage a cough after the online lesson, while no difference is observed for the students in the TBS group (statement No 17). A previous study evaluated students' confidence after performing a paper vs. an online simulated scenario in an osteoarthritis case through a submitted subjective objective assessment plan. The results did not show any difference between the groups, which suggests that the online virtual scenario offered only limited benefit in increasing overall student confidence.[7] In that study, the online virtual scenario (in which the students had to select answers or choose appropriate patient-specific questions) was similar to the TBS that was used in the present study. Based on our results, it seems that an online virtual scenario that includes a looped, branch SG helped students to better understand the aim of pharmacist triage related to a specific topic.

"No prior lecture students" vs "prior lecture students"

Logically, the "prior lecture students" express more positive opinions for pre-test statements related to TBS and skills and knowledge to triage. Pre- and post-test scores in perceived control and especially in skills and knowledge to triage show more changes for the "prior lecture students" whatever the learning tool (seven changes for "no prior lecture students" in the TBS and SG subgroups compared to 12 changes for "prior lecture students" in the TBS and SG subgroups). The "prior lecture students" also give a better evaluation for both learning tools. As expected, a previous lecture helps students to better benefit from an online training tool.

More interestingly, the "prior lecture students" who performed the SG consider that the case helps them to develop their knowledge about cough. This is not the case for the "prior lecture students" who performed the TBS. In addition, the "prior lecture students" who performed the TBS prefer an online training followed by a simulated patient in the classroom. This is not the case for those who performed the SG. Hence, it seems that performing a linear online training such as a TBS could be considered as too simple for students who have already followed a lecture on a topic. On the contrary, an SG could be sufficiently challenging to complete a lecture and substitute for a simulated patient in a classroom. Indeed, the "prior lecture students" seem destabilized by the complexity of the SG. This result is illustrated by the statement that addresses the ability to answer patient questions: they feel more confident before the SG, as their post-test score decreases. Hence, a debriefing in a classroom should be proposed after an SG.

Based on these results, it seems that a previous lecture on triage is not required in the case of simple linear online training, such as the TBS. However, to prepare students to face the complexity of pharmacist triage, more complex simulation is required, such as training with simulated patients. On the contrary, a previous lecture on triage seems to help students to better benefit from a more complex online training, such as the looped, branch SG. Such online training requires a debriefing in the classroom. However, students seem to find it sufficiently complex to be an alternative to training in pharmacist triage with simulated patients.

Study limitations

More students did not start the study in the TBS group. Differences between the groups of students who did not start the study could influence the outcomes, and no data are available about these students.

Most of the students are women. Consequently, these results may not fully extend to male students.

The distance between, e.g., one and two, could be different from the distance between four and five in a Likert scale data. Summarizing such data by the use of the mean and the standard deviation is equivalent to consider these as continuous. Such a presentation could be discussed from a statistical point of view, but it has been chosen to facilitate the presentation of the results.

Most of the students declared training in pharmacy under supervision as a previous experience in pharmacist triage. This experience (e.g., the type of supervision, the advice received) has not been analyzed and could influence some results. However, in Belgium and Switzerland, no guidelines or instructions related to triage are given to pharmacists who train students during their internship. Consequently, no systematic influence is expected from this parameter.

Some of the Swiss students could have read the test from the consumers' association. However, the clinical and pharmaceutical information included in the SG and the TBS is not mentioned in the article that was written for the general public. Therefore, pre-reading the test is not considered to influence the results.

No significant difference is shown for clinical knowledge between “no prior lecture students” and “prior lecture students”, although the latter had a previous lecture on the topic. As the pre-test clinical knowledge is not known, it could not be determined whether the SG and the TBS help the “no prior lecture students” bridge a possible gap with the “prior lecture students”.

Conclusion

These results show that SG and TBS are effective to teach pharmacist triage in the case of a cough. However, SG helped students better understand the aim to triage related to a specific disease. SG was favored by students, even if it was more complex. SG could be an alternative to simulated patient, while this is not the case for a TBS. Hence, complementing a lecture by developing an SG is worth the effort to exercise pharmacist triage related to a specific disease compared to doing so in a simpler linear online training tool, such as a TBS. However, as students can be destabilized, a debriefing in the classroom should be introduced. A simpler linear TBS seems not sufficiently challenging to be an alternative to simulated patients. However, it does not require a previous lecture on a specific disease and a debriefing. These two types of online training should prepare students to better benefit from later training with simulated patients and from their internships.

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Conflicts of interest

None.

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Appendix A. Supplementary material

Supplementary data associated with this article can be found in the online version at http://dx.doi.org/10.1016/j.cptl.2017.11.002.

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