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Article

Cultivating STEM Interest in High School Students through Computer-assisted COVID-19 Pandemic Awareness Course

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Abstract: Due to the COVID-19 pandemic, students were sidetracked by the shift in the educational process, primarily in the field of STEM (science, technology, engineering, mathematics) education. Teachers were also besieged to find sustainable teaching solutions. During this chaos, many were subjected to various rumors and misinformation about the pandemic. Hence, we aimed to design a 3 week long computer-assisted STEM-based health awareness course. The course was designed and delivered to twenty high school students in various public schools in Qatar. The course creators utilized various innovative computer-based educational tools to involve and motivate students. In addition, students attended several synchronous and asynchronous sessions with experts in different fields to gain a better awareness of the crisis. A feedback mechanism was also operated to assess the effectiveness of the course delivery. The results revealed a 100% retention rate. The student questionnaire survey result showed higher post-test scores on pandemic awareness. A SWOT analysis depicted the strength, weaknesses, opportunities, and threats of the executed course. Thereby, we successfully investigated the effectiveness of the STEM-integrated pedagogical approach through the learning outcomes of the student's awareness of the course.

Keywords: STEM education, Digital tools, Computer-assisted, Health awareness, COVID-19

1. Introduction

The COVID-19 pandemic has severely overturned all sectors of society. Amidst the chaos, it is mandatory to make people aware of COVID-19 and its protective measures. This step becomes extremely crucial due to the lack of therapeutic drugs, and the immediate need to diminution the spread of the virus (World Health Organization, 2020). As per the World Health Organization (WHO), the best mode to prevent/ decrease transmission is to well inform the public about the pandemic, its cause, and the transmission. Traditionally, health awareness campaigns educate people regarding diseases, and their spread and consequences (Ahad et al., 2020). The awareness programs are primarily delivered as seminars or workshops. Furthermore, a passive outreach approach is also used to disperse the information using social media platforms. However, dispersing the health information to the addressees is challenging (Lee and Campbell, 2020), and attaining their feedback is even tougher. In a similar context, health awareness campaigns designed for school students are challenging due to poor interactivity, communication, engagement, and retention.

Due to the COVID-19 pandemic, the students were home-confined with few opportunities to partake in extramural activities. Summer break seemed unproductive due to restrictive learning, traveling, or training. The unpredictable pandemic has provided the opportunity to enhance the educational experience by bridging STEM education and technology (computer assistance). Researchers all over the world also stress the importance of STEM education to address global issues (van Tryon and Bishop, 2009). Nevertheless, there is a lack of STEM-based health awareness campaigns that could be effectively implemented during this pandemic situation. Moreover, most online courses have had the drawback of collaborative learning with combined assignments. Researchers and academicians have emphasized the value of collaborative learning to improve students' social behavior and accountability (Brett and Nagra, 2005; Conrad and Donaldson, n.d.; Dawson, 2006; Fisher et al., 2005; Menchaca and Bekele, 2008; Ouzts, 2006; Rovai, 2002). Additionally, the heave of myths and fabrications circulating about the pandemic via social media platforms was regarded as an opportunity to develop an interactive computer-assisted, STEM-based awareness course to address COVID-19.

COVID-19 has provided massive opportunities for students to enhance their innate instincts and transform them into productive skill-based potentials despite the learning crisis. The course content was developed and taught using various digital tools to improve

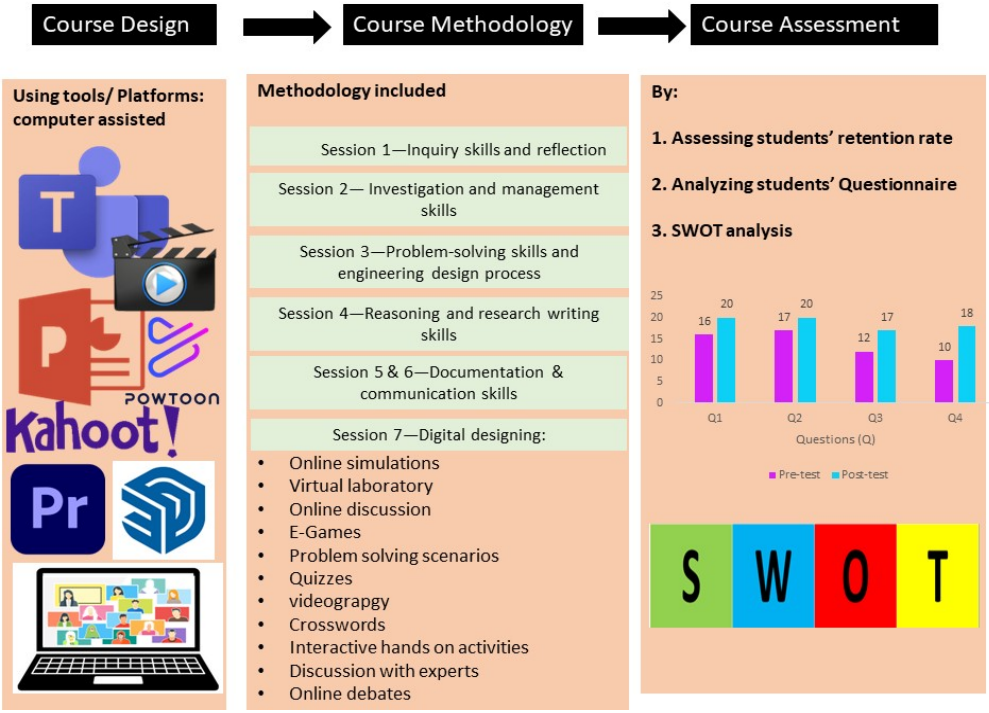
students' scientific knowledge, skills, creativity, collaboration, engagement, and retention. Wherein, the students were involved in pandemic-based scientific projects by participating in diverse STEM-based activities that inspired them to innovate ideas to combat the crisis. Hence, this research focuses on computer-assisted health awareness courses for high school students, keeping in view the demand for STEM learning to support a resilient and skillful generation. Research- and evaluation-based framework has been used to create the interactive computer-assisted health awareness course on COVID-19. The study is based on one group pre-post design. The main aim of the study is to review the utility and applicability of the course designed for high school students. The following research questions (RQs) were addressed in the study.

(1) Does the course design successfully address STEM learning by integrating digital tools?
(2) Can pandemic outbreaks like COVID-19 be effectively used to encourage students to attend a three-week-long course?
(3) Can such virtual courses be effectively used to enhance students' STEM attitudes and knowledge?

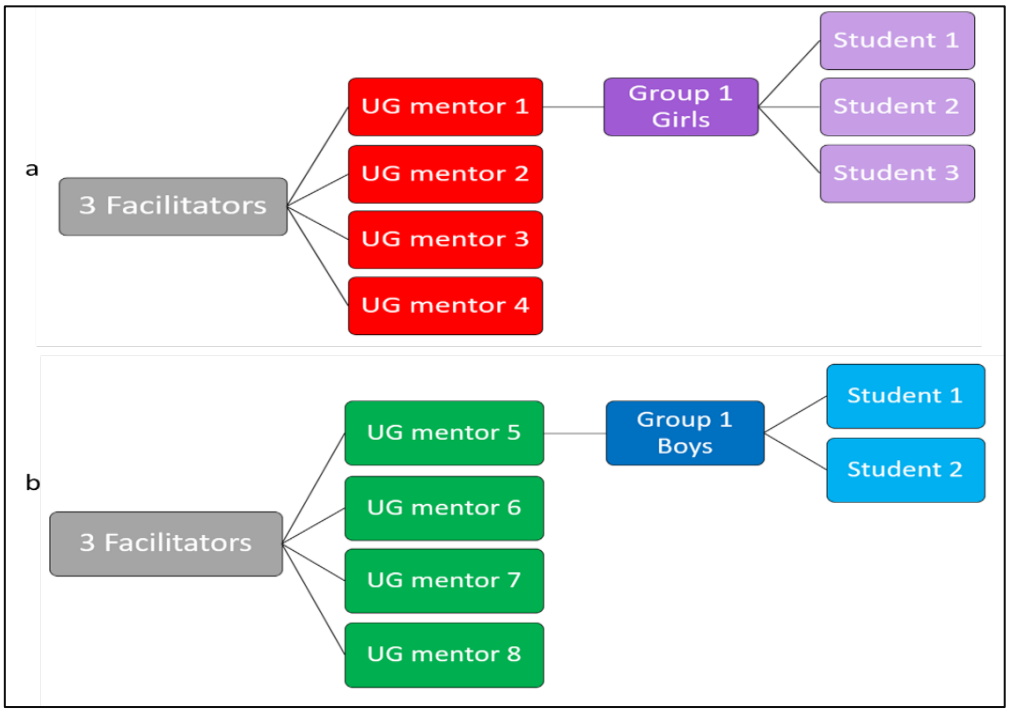
2. Materials and Methods

2.1. Research Methods:

The course was created and delivered by STEM experts from the national university of Qatar who were expertized in designing and teaching STEM-based workshops (Abouhashem, Abdou, Bhadra, Santhosh, et al., 2021; Abouhashem, Abdou, Bhadra, Siby, et al., 2021; Ali et al., 2021). The course creators were denoted as facilitators. 20 students (12 female and 8 male students) from 11 public and private schools in Qatar joined the online awareness course. The course was given in two batches: one dictated for female students and the other for male students in 3 weeks. Additionally, to promote collaborative learning, the students were divided into small groups. There were 4 female groups and 4 male groups. The distribution of students, mentors, and facilitators is depicted in Fig. 1. The participants were selected from the registration list based on a first-come, first-served basis, and priority was given to the Qataris.



(a) Female batch with four female student groups mentored by four UG mentors.



(b) Male batch with four male student groups guided by four student-centered UG mentoring.

Fig. 1. Diagrammatic distribution of facilitators, mentors, and students in the female and male batches of participants.

Eight students guided the participants (high school students) as mentors. They participated in the course as a part of their summer project. Each mentor was designated to one group of students to supervise and observe the students' learning. The students were assigned to groups for collaborative peer-based learning. For the female and male student groups, the student-to-UG mentor ratios were 1:3 and 1:2, respectively. The UG metros observed and recorded the students' attitudes in terms of active involvement, interaction, and responses. They were also responsible for collecting and evaluating the daily students' feedback and informing the facilitators of any instruction alterations if required.

2.2. Course Design

The course spanned three weeks. The facilitators ensured that the program provided sufficient information regarding the pandemic via an innovative exploratory learning experience via a well-structured activity framework. All the learning activities were designed to address diverse learning. Each session covered a different topic concerning the COVID-19 pandemic. For every session, specific objectives are accounted to achieve a set of competencies and experiences.

Session 1—Inquiry skills and reflection

Inquiry skills were augmented via game-based activities. Students' knowledge about the virus was enriched by teaching the basic concepts of virology. They were also evaluated based on their reflection on such a crisis through the integration of STEM education.

Session 2— Investigation and management skills

They were trained to effectually retort to such pandemic situations through knowledge, research, and skills. Where they attain crisis management skills through group discussions with experts and debates.

Session 3—Problem-solving skills and engineering design process

Problem-solving skills were introduced by brainstorming to find solutions for the existing problem by driving students through innovation-based thinking. Wherein the students focus on productive, reproducible, and, reliable outcomes through an engineering design project.

Session 4—Reasoning and research writing skills

Students were introduced to the concept of research methods by allowing them to acknowledge the precautionary measures opted for by different countries. The game-based approaches were used to teach the importance of social distancing. Furthermore, students were introduced to research writing skills, along with scientific research management skills.

Session 5—Documentation

The students were familiarized with the concept of documentation, its significance, and the method of documenting the COVID-19 crisis (in the form of image gathering, video collections, notes, diaries, etc.) through discussions with the experts.

Session 6—Communication skills

The discussions with health professionals from the National Health Service and Qatar University helped the students to improve their communication skills. Experts helped the students to realize the effect of COVID-19 on people/patients with chronic diseases. The discussion also covered the role of nutrition in boosting innate immunity. Such workshops with experts were critical in aiding students' knowledge to acclimatize to a new situation.

Session 7—Digital designing

A digital and graphical design was taught through a basic tutorial on videography by the experts. Students used Adobe Premiere Pro for the generation of a documentary movie assigned in session 5.

The main session spanned an hour, twice a week for 3 weeks. The main session was further subcategorized as an introductory session, a scientific session, and a concluding session (Fig. 2). The introduction and the concluding session were mainly for the smooth transition and the functioning of the course sessions. While the scientific session was designed to deliver the main content (scientific knowledge) ensuring the set learning objectives. A short follow-up session was also included, followed by the main session to track the students' progress. The introductory session was designed to facilitate a smooth transition between the sessions. There were 7 sessions involving exploratory learning with ice-breaking and warm-up activities to ignite students' curiosity toward the sessions' activities. The scientific session was to equip the students with the required knowledge on COVID-19- related topics using digital tools. This session aided the participants to develop and gain various crucial skills. The purpose of the concluding session was to make sure that the students attained their respective skills, aligning with the learning objectives. There was a 30 minutes follow-up session followed by the main session. This session was to augment the main session by tracking the students' tasks. The session also guided the students in the utilization of various ICT tools to complete their tasks (scientific projects, assignments, homework). Follow-up sessions were mainly supervised by the UG mentors.

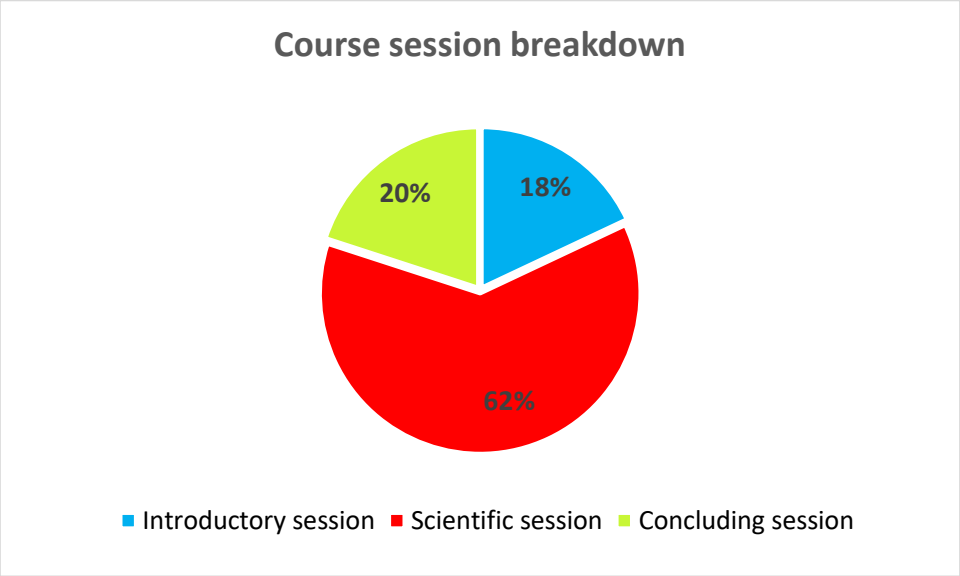


Fig. 2. Distribution of the main session (1 hour): introductory, scientific, and concluding sessions.

2.3. Course platform, learning resources, and assessment

The virtual course has been delivered through the most popular digital platform, Microsoft Teams (MS Teams). All the features of MS Teams were effectively utilized to actively involve students i.e. texting, illustrating statistics, displaying, and sharing various educational tools and media. The features included video conferencing, a text box, screen sharing, sketching using a whiteboard, meeting talks, raising a hand icon, emotional icons, and channel allotment for each student group, and were extensively utilized by the course content developers. The other multimedia tools that were used to officiously deliver the course included images, videos, audio, MS PowerPoint Presentations, and others.

Various computer-assisted tools were employed in the course to deliver the course. These digital tools included Kahoot, WhatsApp, PowToon, Sketch-up, MS PowerPoint presentations, and Adobe Premiere Pro applications. Table 1 details the various tools that were included to create an active learning environment. The employed tools were essential in the completion of various assignments like reports, projects, presentations, and documentation. The assignments were evaluated to check the effectiveness of the knowledge attained, instructional delivery, course content design, and tools employed (Table 1). Thereby supporting/ improving students' attitudes, productivity, skills, creativity, cognitive responses, and active participation. The effectiveness of the course was evaluated by methods, including students' questionnaires, feedback, assignments, and mentors' observations. The course creators designed the assignments as per the desired learning objectives and outcomes (Table 1). The daily feedback measured the students' attitudes, describing their likes and dislikes.

Table 1. Diverse digital tools that were employed during the sessions

Sessions	Digital tool	Topics	Objectives
Session 1	• *Kahoot* • *MS teams* • *MS PowerPoint presentation* • *PowToon* • *WhatsApp*	• Introduction to COVID-19 • Design advertisements (in the form of posters or movies) to create awareness about the pandemic	• To improve students' inquiry and research skills • To evaluate students' reflection on the current scenario.
Follow-up session 1	• *PowToon*	• Tutorial on creating animation using *PowToon*, to design the advertisement.	
Session 2	• *MS Teams* • *MS PowerPoint Presentation* • *Wheel of winners* • *WhatsApp* • *Whiteboard*	• The impact of COVID-19. • The safety of workers, who cannot work remotely • Food security during the pandemic.	• To help attain crisis management skills via discussions and debates.
Follow-up session 2	• *Sketch up*	• Tutorial on creating 3D animation using *Sketch up* to design a 3D model of an innovative device to prevent the spread of the Coronavirus.	
Session 3	• *MS Teams* • *MS PowerPoint Presentation* • *WhatsApp* • *Whiteboard*	• Prototype design that can help reduce the spread of the Coronavirus.	• To help acquire problem-solving skills, and invention skills, via the engineering design process.
Follow-up session 3	• *MS Teams* • *MS PowerPoint Presentation*	• Guiding the students with their prototypes, employing the engineering design process.	
Session 4	• *Kahoot* • *MS Teams* • *MS PowerPoint Presentation* • *PowToon* • *WhatsApp*	• Report writing: A comparative study of the protective measures opted by the countries.	• To enhance students' scientific writing skills
Follow-up session 4	• *MS Teams* • *MS PowerPoint Presentation*	• Reference management in scientific writing.	

Session 5	• *MS Teams* • *MS PowerPoint Presentation*	• Discussion with the documentation experts to learn documentation of the current pandemic.	• To teach the documentation skills
Follow-up session 5	• *MS Teams* • *MS PowerPoint Presentation*	• Follow up with documentation experts to complete the given assignments.	
Session 6	• *MS Teams* • *MS PowerPoint Presentation* • *WhatsApp* • *Recorded videos*	• Discussions with the Health experts from the university and National health services, regarding the virus, its impact on patients with chronic diseases, and nutrition to enhance innate immunity.	• To help gain knowledge by active communication with the experts in COVID-19-related fields.
Follow-up session 6	• *MS Teams* • *MS PowerPoint Presentation*	• Discussion with the experts providing inquiry opportunities for the students.	
Session 7	• *MS Teams* • *MS PowerPoint Presentation* • *Adobe Premiere Pro*	• Documentary movie creation (assigned in session 5) using *Adobe Premiere Pro.*	• To help attain videography skills.

3. Results

The study results showed the efficacy of the course design and implementation. The research findings were based on the assessment of the tools, students' outcomes (assignments- posters, videos, presentations, reports, projects, and others), student attendance, a COVID-19 awareness-based pre-/post- questionnaire, and participant daily feedback forms.

3.1. Assessment of Students' Knowledge

The topic "COVID-19 health awareness" was chosen to educate the youth of the nation. The facilitators ensured that the course activities effectively delivered the participants with the required awareness regarding the pandemic. The course focused on virtual activities during the pandemic-mediated lockdown and was performed from home. Thus, the course content effectually incorporated STEM subjects, augmenting peer collaboration in an active cum social learning environment. In the course, diverse computer-assisted tools such as videos, Kahoot, WhatsApp, PowToon, Sketch-up, and Adobe Premiere Pro were used. The course developers employed course-embedded assessment tools as well to evaluate the students during the session using multiple choice questions (MCQs), quizzes, and games. Assessments of the students' artifacts like the videos, posters, presentations, and reports were also performed.

Students were taught COVID-19-related topics as mentioned in Table 1. They were familiarized with the safety issues faced by the workers who could not work remotely, the food security crisis during the pandemic, and pondered the ways to overcome them. Such activities allowed students to be aware of the pandemic and prepared them to combat the contagion effectively. Wherein, students were motivated to design novel prototypes to reduce the spread of the Coronavirus. In addition, emphasis on oral communication, group live discussions, and debates enriched students' knowledge in peer-based learning. It was observed that the students' crisis management skills were improved through simulated reality experiences. They also conducted comparative studies of pandemic responses in various countries. The comparative study was submitted in the form of a report through which they learned the concept of research, inquiry and logical reasoning, scientific writing, and referencing. In the following stage, they learned the concept of documentation of emergent events as a source for preserving data for future utilization. Discussions with documentation experts were conducted to teach and evaluate the student's skills in documentation. Once they acquired the basic skills of documentation, they were introduced to computer-assisted tools to record their data. Thus, digital tools such as Adobe Premiere Pro was extensively used by the students to document their experience and knowledge of the pandemic. Furthermore, amid rumors, and misinformation, truthful information from reliable sources was found. Hence, the sessions of health experts from the National Health Service on COVID-19 and its impact on chronic disease patients were delivered to students. In addition, a presentation by a nutritionist from Qatar University emphasized the importance of improving innate immunity through their diet. Therefore, students'

curiosity was ignited, and they came up with many different questions. Those questions were directly addressed by the experts in during the follow-up sessions.

After making sure that the student attained the most from the awareness course, post questionnaires were analyzed. Pre- and post-testing were utilized to directly assess the before and after effects of students' learning. The three scientific questions of MCQs nature were utilized to measure the students' knowledge. The questions were about COVID-19 and preventive measures. The questions were as follows.

Q1: RNA is the genetic composition of Coronavirus.
Q2: An action in which you deliberately increase the physical space between the people to avoid spreading the illness
Q3: Which is best to use to dissolve the lipid layer of the Coronavirus?

Figure 3 illustrates the pre- post- data, depicting the number of students who answered correctly. Greater post-data revealed enhanced students' knowledge regarding the pandemic.

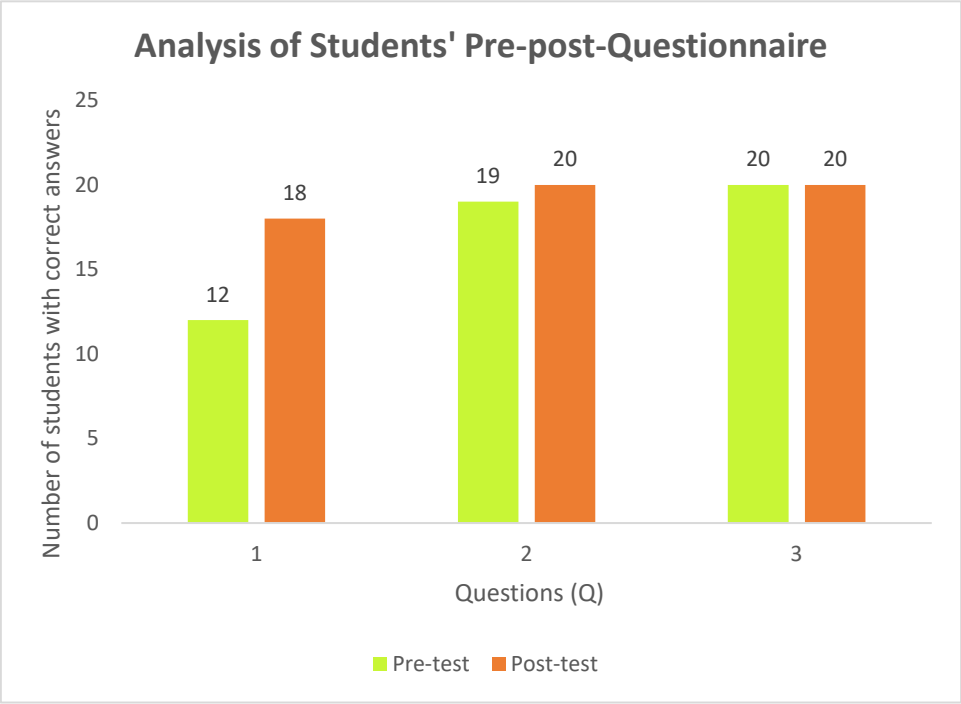


Fig. 3. Analysis of students' pre-post questionnaire in terms of scientific knowledge attained. The graph represents the number of students who answered correctly to the three questions.

3.2 Student retention

The students' retention through the three weeks course was assessed by evaluating the attendance forms. A total of twenty-eight students registered for the summer course. As illustrated in Fig. 4, twelve females and sixteen males registered for the course. All the female students enrolled in the course, while only eight males enrolled in the course, due to different reasons.

An orientation session prior to the course was key to retaining the students. The orientation session provided all the required information such as the course theme, number of sessions, time and duration, evaluation process, expected outcomes, and so on. In addition, the participants ask any questions and clear, any doubts they may have, to avoid any possible withdrawals from the course. Thus, the results revealed that the course maintained the highest possible retention rates in long 3-week sessions. Figure 5 depicts that all the enrolled students completed the course sessions successfully without withdrawal..

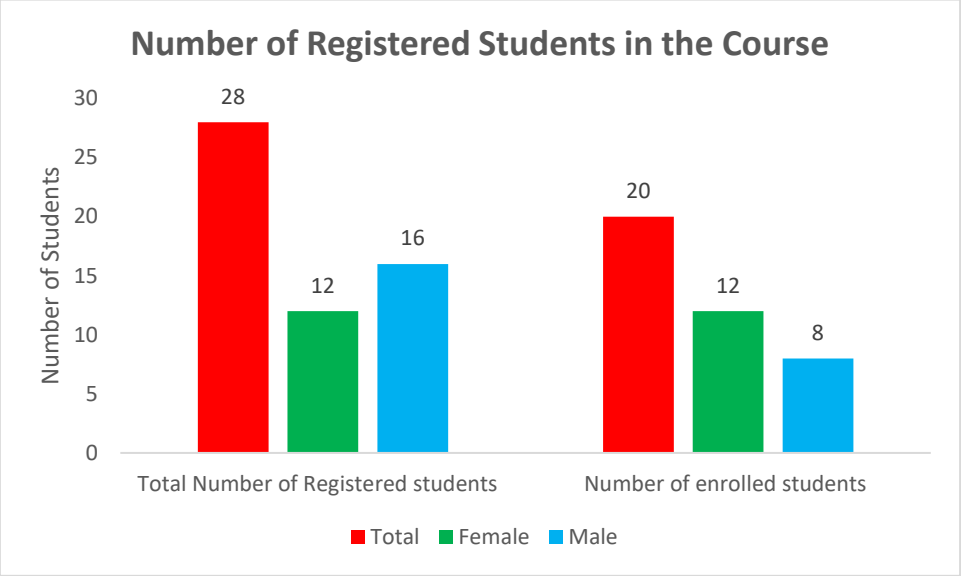


Fig. 4. Number of students who registered in the course, with the number of students who agreed to enroll with the unenrolled students is represented graphically.

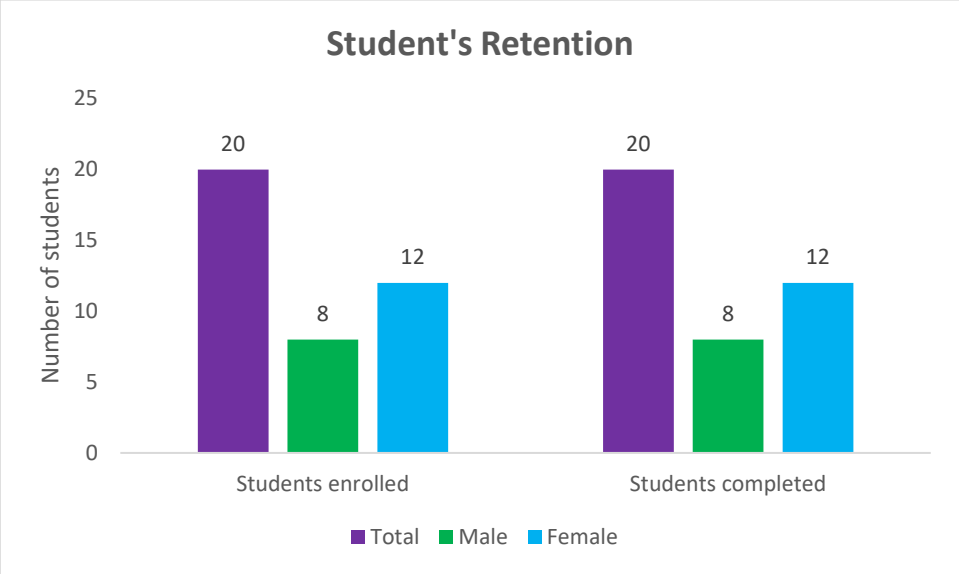


Fig. 5. Graphical illustration of the students' retention throughout the course, revealing a 100% retention rate without any withdrawals.

3.3. Students' attitudes

The course was successful in developing students' attitudes. Their attitudes were assessed through the quantitative and qualitative analysis of students' pre-post questionnaires, and mentors' feedback. Students were asked 4 questions in the pre-and post-questionnaire regarding their perception, skills, and competencies, during online learning. The questions were 'Q1: I can understand the scientific concepts easily during online learning', 'Q2: I can actively communicate with my peers during online learning', 'Q3: I feel confident to do research and assignments online', and 'Q4: I have the skills to propose innovative solutions to a problem'. Figure 6 present that all the students showed better post scores, revealing enhanced students' attitudes (in terms of interest, ease to learn remotely, confidence and skills) after the course.

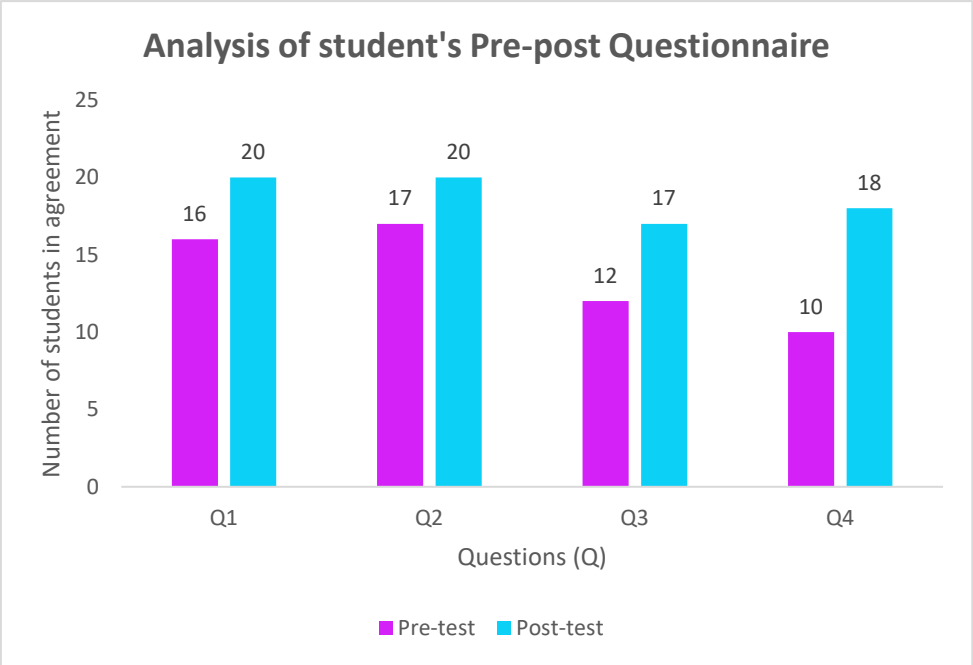


Fig. 6. Analysis of students' pre-post questionnaire, in terms of students learning behavior. The graph represents the number of students who agreed to the four questions (Q1, Q2, Q3, and Q4).

3.4 Student feedback

The daily feedback was essential to assess the course's effectiveness as it allowed any alterations in the instructional practices (as per the need). A qualitative analysis of the student's feedback was performed. The UG mentors were responsible for feedback collection. They constantly notified the facilitators about the requirement to enhance any instructional practices based on the student's preferences. Table 2 shows the example of three random students' expressions in their feedback form. Because of this process, students are equally involved in pedagogical reforms.

Table 2. Random samples of students' expressions from the students' feedback

Participants	What did you like the most in the session?	What did you like the least in the session?	What would you like to change for the next session?
S1	I like the competition method and the idea of teams, and it is fun that we are answering the questions in a new way instead of the traditional way	It was a little long	Install a schedule for a week with all times for the sessions
S2	The idea of the team challenges is beautiful, and I hope I win every time and the games were beautiful and varied.	I just hope that we do not spend a lot of time waiting for one person.	Nothing in particular
S3	The competitions and challenges we do increase our enthusiasm. In the beginning I was bored after the challenges started, I was excited and interacted	some groups are not interacting, I mean, we do not hear their voices, so they do not cooperate and the things that need to be settled as a team	Be aware of scores

4. Discussion

The design and implementation of the health awareness course have limitations in terms of interactivity, communication, and engagement. Particularly, in the school health awareness programs, the students are generally attending long lectures with rare opportunities for active learning. During the COVID-19 pandemic-mediated lockdowns, the scenario reduced opportunities for activity-based learning. In addition, they were subjected to the circulating misinformation and rumors via social media platforms.

Thus, it was essential to upgrade the conventional health awareness course into an interactive virtual STEM-based awareness course. Thus, we aimed to find a way of effectively using the COVID-19 outbreak as an opportunity to design such an awareness program. Therefore, the facilitators designed a computer-assisted course to retain and motivate the students' knowledge, interests, and productivity. Overall, the program appeared to be highly successful as students shared their positive experiences and expressed interest and reflections. The course design, content, and, implementation, were thoroughly evaluated in terms of its strengths and weaknesses, opportunities, and threats (revealing the facilitator's perspectives. Thus, a SWOT analysis matrix was constructed as shown in Fig. 7.

S	W	O	T
• High student retention rates. • Integration of STEM in a health awareness course • Flexible & student-centered learning • Live discussions with experts • Computer-assisted learning using various digital tools & platforms • Feedback mechanism-driven course methodology	• Quantitative analysis of students' competencies. • Low participants' size. • Limitations in hands-on experiments due to covid-19 restrictions (online course).	• Online collaborative programs. • Large-scale health awareness outreach. • Mental motivation and cognitive development. • Promising approach for health awareness campaigns.	• Online technical glitches. • Limited alternatives in virtual platforms.

Fig. 7. Facilitators address the strengths, weaknesses, opportunities, and threats (SWOT) of the course.

5. Conclusions

This study involved twenty high school students from Qatar to overcome the shortcomings of conventional health awareness campaigns by designing a STEM-based computer-assisted course. The facilitators came up with various dynamic ways to engage students by using computer-assisted tools such as interactive quizzes, active games, and engaging activities. A mixed analysis of the students' pre-post questionnaire, daily post-session feedback, and mentors' observations were performed. A qualitative SWOT analysis was also performed to provide clarity on the study. The results revealed the successful implementation of the STEM-based awareness course, where all the proposed research questions were addressed. The evaluation of the attendance report revealed the students' motivation to enroll and retain in the course. Pre-post questionnaire analysis showed enhanced post-test scores in terms of knowledge, attitudes, and skills. Thus, the study has effectively detailed the instructional practices and diverse dynamic strategies for designing a virtual health awareness course. The program engaged students productively to enhance their knowledge, skills, and attitudes. Therefore, this study result provides immense scope for the researchers and academicians who intend to design, develop and implement effective computer-assisted STEM-based health awareness courses.

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Conflicts of Interest: The authors declare no conflict of interest

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