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Students' perceptions of competency-based learning environment during COVID-19: a mixed-methods approach

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The COVID-19 pandemic has had many reflections on teaching and learning. Competency-based learning (CBL) is outcome-based learning that supports students to focus on competencies and improve their learning skills. It was helpful for the universities during the pandemic to offer an effective online learning environment for computer science students. This study evaluated the CBL experience from the perspective of computer science students. The study used a mixed-methods approach and obtained data from 104 participants using an online questionnaire and in-person interviews. The study's findings indicated that the quality of the teacher, the learning environment, time management, and the expectations positively influenced student satisfaction, which in turn positively influenced students' performance. The investigation found statistically significant evidence that the CBL was helpful for students' skill improvement. Additionally, this study presented the challenges and limitations of CBL, which can inform universities and course developers to improve the standards of CBL. Using this study's implications, academic researchers can extend their research to develop innovative approaches for the CBL environment.

KEYWORDS

computer students' perceptions, online learning, COVID-19, blended learning, educational innovation, mixed method approach

1. Introduction

COVID-19 is a highly contagious disease rapidly spreading throughout the human population (Francis et al., 2019). In December 2019, a new strain called COVID-19 was first identified in Wuhan, China (Bedenlier et al., 2021). Over 817,127 confirmed cases of COVID-19 and 9,361 fatalities were reported to WHO from Saudi Arabia between 3 January 2020 and 7 October 2022. A total of 67,839,503 doses were given as of 26 September 2022 (Ministry of Health, 2022). The Saudi Arabian government ordered a nationwide lockdown of schools and universities to prevent the spread of the coronavirus among students. The widespread shutdown of educational institutions brought several challenges in continuing educational activities.

UNESCO suggested that schools and instructors employ distance-learning programs and open educational software to continue teaching students. As a result, many academic institutions preferred to offer courses exclusively online (Yeung and Yau, 2022). Khalil et al. (2020) state that universities and colleges employed new educational technologies and provided a virtual learning environment during the COVID-19 pandemic (Curelaru et al., 2022). However, the recent technologies have limitations, including the lack of

infrastructure, training, flexible technology, and unstable internet facilities. Thus, there is a demand for a study to evaluate the performance of recent educational technology. Therefore, the current study aimed to investigate the students' perceptions of the new learning environment during COVID-19.

Institutions shifted to E-learning to deliver instructional activities (Koskey and Benson, 2017; Lee-Post and Hapke, 2017; Wong et al., 2019; Yeung, 2020). E-learning or distance education is a new paradigm for teaching and learning in the digital age (Zhong, 2020). Scholars, instructors, and other professionals are interested in how online education enhances traditional methods of instruction. Examining student satisfaction and academic success is the only way to identify the effectiveness of educational technology (Williams, 2019).

Blended learning has been investigated in recent studies. It has been found to produce significantly better student outcomes compared with traditional classroom-based instruction. Galan et al. (2019) explored the challenges teachers had with the transition from traditional classrooms to online learning environments. Numerous studies on online education have been conducted to address challenges, including learner satisfaction, e-learning acceptability, variables contributing to the success of distance education, and the effectiveness of competency-based learning (CBL). However, the evidence is limited regarding the characteristics influencing students' satisfaction with the CBL method during the Covid-19 Pandemic (Brilingaite et al., 2018). Course design, teacher quality, timely feedback, and student expectations are the essential factors determining students' satisfaction with the CBL (Carrillo and Flores, 2020). Curriculum understanding, program structure, educational aims, and course outline are all components of the course design (Carrillo and Flores, 2020). Students are more likely to be satisfied with the system if their courses are well-designed (Toader et al., 2021).

Dumford and Miller (2018) suggested that well-designed courses might boost students' performance. Online education can help teachers and students improve their skills (Curelaru, 2021). The organized course structure can enable students to accept the new learning environment. The quality of the instructors is another major determinant of the success of the CBL environment. The term "instructor quality" describes a professional who is sensitive to the requirements of their students, possesses innovative teaching methods, and knows how to tailor their lessons to each individual's strengths and weaknesses (Ensmann et al., 2021).

Researchers discovered that improved learning outcomes might be achieved through a stronger relationship between teachers and students (Given, 2008; Kastanakis and Voyer, 2014; Gallardo, 2020). Verderame et al. (2018) studied the effect of students' expectations on their academic outcomes. They recommended paying attention to students' expectations. Satisfaction levels were higher among students in higher grades than those in lower grades.

The education process is deeply connected to strengthening the competitiveness of educational institutions and the quality of their offerings. From a process perspective, high-quality education may be defined as one in which teaching and learning are carried out efficiently and creatively, facilitated by sufficient human and material resources and infrastructure. Competent professionals can be expected to emerge from a rigorous educational system. Low education quality is generally responsible for relatively low human resources quality. Enhancing teaching methods is one way to raise standards in the classroom. Effective learning demands professional dedication from instructors and students in the classroom to realize the full potential of an excellent education. In Saudi Arabia, educational institutions offered supportive learning environments for computer science students during the COVID-19 pandemic. However, research needs to probe students' perceptions of the CBL environment.

People who pursue higher education expect significant success levels (Partovi and Razavi, 2019). For competition in information technology, universities provide recent technologies in computer courses. Thus, universities focus on teaching computer courses to equip students with skills valued by employers and graduate programs. However, universities face challenges and limitations in delivering practical sessions for computer students. The purpose of this study was to collect data to evaluate computer students' perceptions of the CBL environment. It aimed to identify the challenges in implementing CBL as an alternative to traditional teaching methods. Students' perspectives on online education during the recent COVID-19 Pandemic in KSA should be addressed. Most existing research employed quantitative methods in exploring students' experiences in the CBL environment. This study contributes to the literature by using both quantitative and qualitative data collection to identify the difficulties faced by students. The study's findings can support educational institutions in enhancing teaching methods and online learning environments. The study addressed the following questions:

- In light of the current global pandemic, what difficulties do students face in the CBL environment?
- Amid the COVID-19 pandemic, what methods are employed to address the difficulties associated with online education?
- How can a CBL environment be improved to continue after the COVID-19 outbreak?

The study's novelty was identifying students' perceptions of the CBL environment using the mixed-methods approach. The author validated the qualitative outcomes using the quantitative findings. Based on the existing literature, the study uniquely addresses students' perceptions of the competence-based learning environment during COVID-19 in KSA. Thus, policymakers, educational authorities, professors, and other stakeholders can address students' needs in the online learning environment.

In Section 2, the author presents the theoretical background of CBL and self-regulated learning approaches. Section 3 outlines the process of data collection and analysis. The study's findings are presented in section 4. In section 5, the author compares the study's findings with existing studies. Section 6 discusses this study's key features and suggests further research directions.

2. The theoretical background

CBL environment separates teachers and students during teaching and uses various technologies to allow student-teacher and student-student interaction (Francis et al., 2019; Khalil et al., 2020; Bedenlier et al., 2021; Ministry of Health, 2022; Yeung and Yau, 2022). Researchers suggested that online classes could be as

practical as traditional classroom instruction. In the past, distance education was used during times of emergency, such as a pandemic or natural disaster. However, COVID-19 presents a novel and challenging circumstance (Curelaru et al., 2022).

The digitalization of teaching and learning is linked with lifelong learning and adaptation to the current labor market. However, it was not yet implemented across the KSA until COVID-19, notably in higher education. Therefore, examining how students perceive the new learning environment and the possibilities of implementing CBL as an alternative to the conventional learning environment is crucial.

Flexibility in scheduling, personalization of the learning process, the possibility to improve computer skills, and the ease of information delivery are only a few advantages of CBL over traditional face-to-face instruction (Koskey and Benson, 2017; Lee-Post and Hapke, 2017; Brilingaite et al., 2018; Galan et al., 2019; Williams, 2019; Wong et al., 2019; Yeung, 2020; Zhong, 2020). However, there can be both benefits and limitations to online education. The higher flexibility of distant learning sets significant demands on the learner's capacity to manage their learning and motivation, posing an increased risk of passive procrastination.

Recent studies addressed the importance of CBL for student achievement in face-to-face and online classrooms (Dumford and Miller, 2018; Carrillo and Flores, 2020; Curelaru, 2021; Ensmann et al., 2021; Toader et al., 2021). Self-regulated learners can actively manage their learning process by setting objectives, organizing their time and activities, evaluating their progress, and controlling their motivation. As a result of the less rigid nature of distance education, students should manage their learning environment. Distance learning environments require competencies such as goal setting, time management, and metacognitive strategies like monitoring and assessing progress toward goal accomplishment (Given, 2008). The existing literature suggests that students demand additional assistance to self-regulate their learning (Kastanakis and Voyer, 2014).

Intrinsic motivation is another critical component in student achievement. It significantly predicts learning success, e.g., reading achievement and higher grades. At the same time, extrinsic motivation relies on external rewards or punishments, which may be counterproductive to academic achievement and well-being (Gallardo, 2020). According to the self-determination theory, intrinsic motivation occurs when an activity meets the desire for perceived competence and autonomy (Verderame et al., 2018). The motivational effects of autonomous learning contexts like distance learning depend on the actors' beliefs about their abilities to meet the challenges presented and realize their goals. Therefore, one's sense of competence may be a reliable indicator of intrinsic motivation.

It has been demonstrated that utilizing CBL strategies and high motivation predict academic accomplishment. In education, passive procrastination refers to delaying responsibilities linked to academics even when confronted with the possibility of unfavorable outcomes. Active procrastination, a kind of self-regulation unrelated to adverse effects, has been distinguished from its passive counterpart (Partovi and Razavi, 2019). The role of perceived competence for passive procrastination, in contrast to CBL and motivation, is less frequently studied. Students' perceptions of their abilities indirectly predicted their tendency to delay their tasks (Venkatesh et al., 2020). Another study indicated that students' perceptions of their abilities moderated the relationship between failure anxiety and avoidance behaviors like passive procrastination.

The relationship between CBL and motivation has not been studied, though several studies demonstrated the relevance of perceived competence and the increased risk of passive procrastination (Onyema et al., 2019; Kononets et al., 2020; Nurtanto et al., 2020). To address this research gap, the current study uses the mixed-methods approach to identify the relationship between perceived skills in the CBL environment. In addition, it addresses the challenges and limitations in implementing an effective CBL environment for computer science students.

2.1. Proposed hypotheses

Based on the existing literature, the dependent and independent variables were identified as shown in Figure 1. The independent variables are the learning environment, time management, technical challenges, teaching methods, and expectation, whereas the dependent variable is the quality of the CBL environment.

H1: There is a positive relationship between the learning environment and the quality of the CBL environment.
H2: There is a positive relationship between time management and the quality of the CBL environment.
H3: There is a positive relationship between technical challenges and the quality of the CBL environment.
H4: There is a positive relationship between teaching methods and the quality of the CBL environment.
H5: There is a positive relationship between expectation and the quality of the CBL environment.

3. Methods

To test the research hypotheses, a mixed methods approach was applied. The qualitative method allows a deeper evaluation of phenomena (Lee-Post and Hapke, 2017; Mahasneh and Alwan, 2018; Hewat et al., 2020; Khalil et al., 2020; Curelaru et al., 2022; Yeung and Yau, 2022). The author presents the findings using the COREQ methodology, which combines many guidelines for reporting qualitative research (Hewat et al., 2020). A qualitative research method (Galan et al., 2019) explores how students in this new curriculum use self-learning techniques. However, a quantitative analysis was employed to validate the qualitative findings. The Institutional Review Board (IRB) approval was obtained from Shaqra University. During the COVID-19 pandemic, Shaqra University introduced a new competency-based program that emphasizes combining academic theory with hands-on practical experiments. The author interviewed students from the whole academic spectrum, including those who were at the top of their class, those who were struggling, and those who had shown significant growth over the year. After acquiring the ethics approval, the necessary support for conducting interviews in the virtual space with students was obtained from the relevant authorities of Shaqra University, Kingdom of Saudi Arabia (KSA).

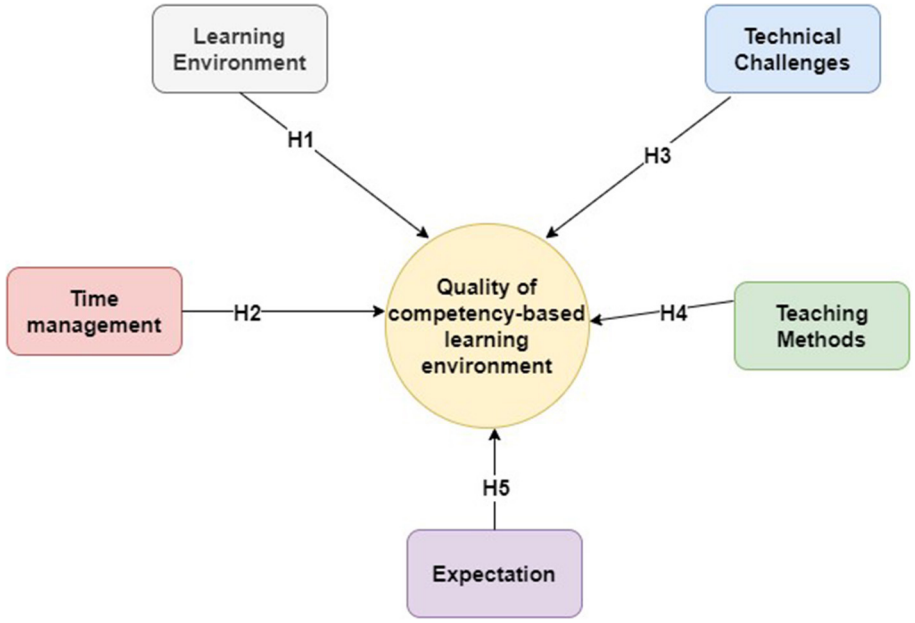

FIGURE 1
Dependent and independent variables.

The participants in this research were undergraduates majoring in computer science. In order to ensure that the questions were appropriate, the author conducted a pilot study. Moreover, the questions were developed and validated by two specialists. The pilot study included input from 20 participants. Revisions were made to the questions based on the results.

The author obtained the participants' informed consent after explaining the study's purpose to them prior to administering the survey. Participants were given a copy of the study's rationale along with the online questionnaire. Participants were asked to send their written consent to the designated email address. They were also assured that no third parties would have access to their information. The author informed the subjects that they would not be compensated for their time. Moreover, participants were not obligated to continue the survey and could terminate their participation at any time.

Emails and Zoom sessions were the primary modes of communication between the author and the participants. The computer science department chair distributed the questionnaire to the participants using their email addresses. An overall sample size of 125 was targeted for this study. Throughout November and December of 2022, respondents filled out the questionnaires. Eventually, 104 replies were received, with a final response rate of 83.2 percent.

The author followed a quantitative approach to validate the qualitative results. He applied confirmatory factor analysis (CFA) to evaluate the reliability and validity. The data were analyzed using IBM SPSS 18.0 with the AMOS package. The measures, including chisq/df, GFI, CFI, MFI, and RMSEA were used for the evaluation. Finally, the internal consistency of the responses was analyzed by exploratory factor analysis (EFA). Cronbach's alpha coefficients, composite reliability (CR), and average variance extracted (AVE) were used to guarantee the questionnaire's internal consistency. Finally, the hypotheses were tested by correlation and regression analysis. Figure 2 highlights the study design for collecting, evaluating, and interpreting student responses. Eqns. 1–4 outline the mathematical form of correlation, regression, AVE, and CR, respectively.

$$P = \frac{n\left(\sum_{i=1}^{n} FS\right) - \left(\sum F\right)\left(\sum S\right)}{\sqrt{\left[\left[n\sum_{i=1}^{n} F_i^2 - \left(\sum_{i=1}^{n} F_i\right)^2\right]\left[n\sum_{i=1}^{n} S_i^2 - \left(\sum_{i=1}^{n} S_i\right)^2\right]\right]}} \quad (1)$$

Where P is a Pearson correlation, F is the first variable, S is the second variable, and n is the number of values.

$$Q_{CBL} = \left(LE + TM + TC + TM + Exp\right) + \in \quad (2)$$

Where Q_{CBL} is the quality of the CBL environment, LE is learning environment, TM is time management, TC is technical challenges, TM is a teaching method, Exp is an expectation, and $\in$ is an error rate.

$$AVE = \frac{\sum \lambda_i^2}{\left[\sum \lambda_i^2 + \sum_i var\left(\sum \varepsilon_i\right)\right]} \quad (3)$$

$$CR = \frac{\left(\sum \lambda_i\right)^2}{\left[\sum \lambda_i^2 + \sum_i var\left(\sum \varepsilon_i\right)\right]} \quad (4)$$

Where λ_i is the component loading to an indicator and $var\ (\varepsilon_i) = 1\text{-}\lambda_i^2$

Students were aided in changing their profile name and answer the survey through text message or audio recording if they wanted to remain anonymous during the survey. For each 20–30 min session, three or four students participated. Each session included

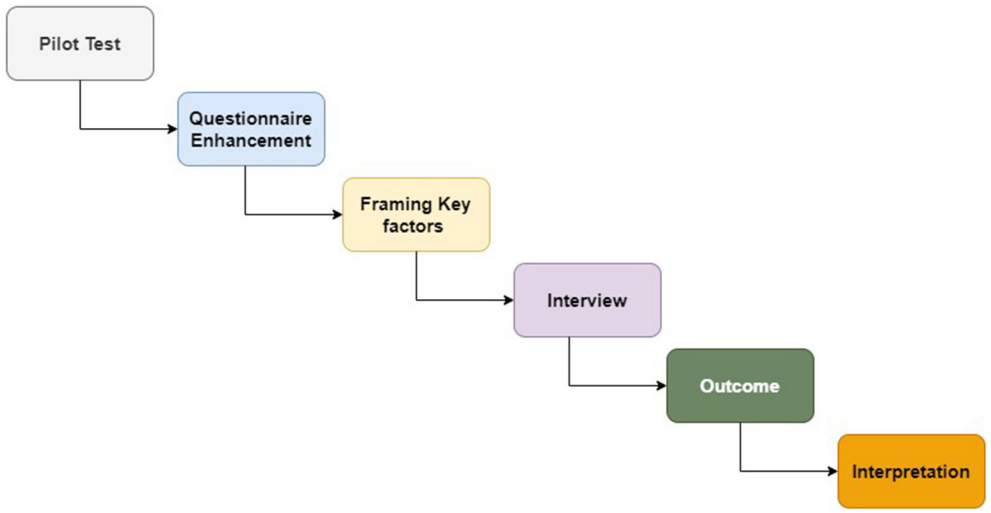

FIGURE 2
The methodological sequence of the study.

two facilitators, one of whom was a teacher in the same field. Students from all levels and sexes were invited, and considerable effort was made to ensure that representatives from each academic area were included. A total of 104 individuals (50 female and 54 male) participated in the survey. The interview was conducted with students of computer science ($n = 47$), information systems ($n = 25$), and computer engineering ($n = 32$). Participants had to be willing to participate and be enrolled in a computer program at Shaqra University. At the outset of every interview, the author inquired about the interviewee's familiarity with the CBL environment. Table 1 presents the participants' characteristics.

Constant sampling was carried out until there was insufficient information to extract any other codes, at which time the regulations became iterative. Research validity, correctness, and soundness were demonstrated by four criteria: credibility, dependability, confirmability, and transferability. Allocating sufficient time for data collection and sustained participation on the author's part allowed the study to meet the first condition. To meet the criterion for dependability, an external expert evaluated data collection, analysis, and findings. The codes and categories were validated and developed based on student interviews by soliciting feedback from other faculty members. Maximum variation sampling, in which individuals of varying ages and sexes from various academic fields were chosen, yielded the data needed to establish the transferability criteria.

Online data collection was included in the original research design to handle unexpected events. The interviewer and the interviewee coordinated their schedules to conduct these interviews at convenient times. To obtain information, a web-based questionnaire was employed. The questionnaire was divided into two parts: In the first section, students were asked to answer open-ended questions about their difficulties in the CBL environment. The second section covered demographic information, such as age, gender, education level, and internet activity. All of these inquiries were designed to elicit open-ended answers. More replies were received because participants were guided step-by-step and provided concrete examples of what was expected of them. This method guaranteed the provision of "thick descriptions" to facilitate more in-depth analysis. The author's prior knowledge, in-depth interactions with students, and discussions with peers all played a role in the development of the questionnaire, which was then applied to the study's target population.

The author transcribed the audio recordings of the participants. He double-verified the correctness and quality of the response with the audio records to ensure they were accurate and of high quality. This investigation used a theme analysis method by Sarker et al. (2019). This method comprehensively describes the dataset by locating the data's themes and potential subthemes. On the other hand, thematic analysis typically delves further by providing interpretations of the issue from several angles.

The author started by reading the data and taking copious notes to extract the interesting themes. In order to fully immerse oneself, one must read the data numerous times while actively looking for meanings and patterns. The author started making coding notes during this stage to guide the following stages. The transcription procedure involved recording every spoken and non-spoken word verbatim. The author ensured that the transcripts had intact information, which allowed for a more thorough examination of the data. The second step was to find the first codes in the information. It organized the raw data into relevant groupings by identifying exciting portions of the data or information. All actual data extracts were coded and collected inside each code, and the original codes found were matched with data extracts indicating that code.

The third analysis phase generated the codes into possible themes and categorized them into specific topics. In the fourth phase, the author examined the themes using thematic mapping. They verified the themes' applicability by comparing them to the complete dataset. All the relevant information for each subject was collected at this point. For this reason, pertinent data was compiled for each potential topic to evaluate the coding accuracy. Data were extracted if the themes were crucial to the whole dataset. Each

TABLE 1 Characteristics of the participants.

No.	Variables	Total ($N = 104$)	Percentage
1	Gender		
	Female	50	48.08
	Male	54	51.92
2	Specialization		
	Computer science	47	45.19
	Information systems	25	24.04
	Computer engineering	32	30.77
3	Province		
	Eastern	27	25.96
	Western	25	24.04
	Central	42	40.38
	Other regions	10	9.62
4	Course level		
	Level 1	12	11.54
	Level 2	17	16.35
	Level 3	14	13.46
	Level 4	14	13.46
	Level 5	19	18.27
	Level 6	18	17.31
	Level 7	6	5.77
	Level 8	4	3.85
5	Stable internet connection		
	Yes	98	94.23
	No	6	5.77
6	Experience with web applications		
	Novice	35	33.65
	Average	27	25.96
	Expert	42	40.38

theme's central meaning and facts were determined in the fifth stage. Extracts from the gathered data for each topic were organized into a consistent explanatory narrative highlighting the subthemes' interactions with the primary themes. In order to reduce the possibility of bias, the author was responsible for the bulk of the coding and arrangement of codes into themes. By processing the transcribed texts, the author examined the emergent themes better and drew out their underlying structures for closer analysis. In the end, the author reviewed the themes and analyzed them according to the study's objectives. Inductive methods were used for data analysis (Lee et al., 2020), which extracted pre-existing patterns and identified unique ones.

The software version MAXQDA V. 2020 was used to analyze the data. The author adopted Graneheim and Lundman's seven-stage content analysis procedure to examine the data. The survey was conducted over WhatsApp and Email applications. The data was collected in a text file format, coded, and broken down into individual words, phrases, sentences, and paragraphs to determine their meaning. Finally, the text was analyzed after coding, compared for similarities and differences, and organized into broader groups. The subsequent phase thoroughly examined the significant regulations. The study's ethical consideration entailed informing participants of their ability to withdraw from the study at any time. Their privacy would be protected if they agreed to be interviewed and recorded.

4. Results

The item loadings of the variables are shown in Table 2. The results show that adequate item loading and communality were obtained for all variables. For instance, the learning environment had weights of 0.85–0.87. The items obtained communalities ranging between 0.83 and 0.85, Eigenvalues of 3.47, and Cronbach's alpha of 0.95.

The values of AVE and CR for both the dependent and independent variables are presented in Table 3. The result indicated that the variables' significance is above the minimal AVE and CR. In addition, the suggested model is effective as indicated by a Goodness of fit index value of 0.924.

Correlations among variables are shown in Table 4. All variables correlated significantly with each other. Furthermore, according to the established precedents, each variable's items are significantly inter-correlated.

Finally, the regression results for each hypothesis are shown in Table 5. R2 and standardized parameters provided strong evidence in favor of the hypothesis. The significance level (R2) for H1 is 0.56, whereas the values for H2, H3, H4, and H5 are 0.59, 0.71, 0.69, and 0.84.

Five primary themes were identified and the sub-themes were classified under those themes. These five themes are outlined in Table 6, along with pertinent participant comments. The five themes are a learning environment, time management, challenges, assessment, and future preferences.

4.1. Theme 1: learning environment

Some students believed that few courses require in-person attendance at universities rather than delivered online, such as practical sessions where demonstrations and practice were crucial. For instance, the following response reflects the participants' opinions on the CBL environment.

> "I think online classes are great for theoretical subjects but not practical subjects. I am not fully satisfied with the CBL environment."

Student experiences varied depending on academic standing. Some students in levels 7 and 8 who took use of online courses made the following remarks:

TABLE 2 Factor analysis outcome.

Variables	Number of items	Item loadings	Communality	Eigenvalue	Percentage of variance explained	Cronbach's alpha
Learning environment	4	0.85–0.87	0.83–0.85	3.47	81.76	0.95
Time management	4	0.86–0.88	0.75–0.77	4.15	79.52	0.96
Technical challenges	5	0.94–0.97	0.81–0.83	3.87	83.56	0.97
Teaching methods	4	0.94–0.96	0.86–0.88	3.68	89.66	0.96
Expectation	5	0.84–0.86	0.85–0.88	3.87	84.56	0.94
Quality of CBL environment	4	0.79–0.83	0.83–0.89	5.12	88.58	0.92

TABLE 3 Reliability.

Variables	AVE	CR
Learning environment	0.779	0.906
Time management	0.589	0.867
Technical challenges	0.735	0.887
Teaching methods	0.678	0.912
Expectation	0.806	0.909
Quality of CBL environment	0.779	0.893

Significance level $p < 0.01$, GFI = 0.936, AFGI =0.888, RMSEA = 0.083, CFI = 0.946, TLI = 0.909, Chisq/df = 1.689.

> "We gained much from online sessions like seminars and workshops, and we found that some online learning courses such as data science were beneficial."
>
> "I was able to invest a lot of time and effort into courses centered on artificial intelligence since I could take them online."

Some introverted or timid students credited online education. The CBL environment supported them in becoming skillful and confident. Feeling comfortable and secure in their surroundings provided them with confidence. Specifically, a participant reported:

> "I was comfortable in the exams and focused on the course material without distractions thanks to the option of completing the exam at home."

4.2. Theme 2: time management

Participants recurrently mentioned time management, and all respondents agreed that their productivity and efficiency had increased due to the online classes. This is evident from the following statement.

> "Since I live far away from the college, attending class typically wastes much of my time. Consequently, I saved time and energy by taking classes online rather than commuting to and from college daily."

Managing their time effectively while studying online was a significant concern for students. In particular, many participants could not meet assignment due dates because of ambiguities in the accompanying instructions. The students assumed the due dates were hidden and weren't communicated clearly and uniformly. The following responses reflect the participant's perceptions of the assignment deadline:

> "Some due dates are not discussed in class, and I was worried I would miss them. Our teachers always reminded us in the traditional setting when due dates were approaching."
>
> "In order to pass some classes, I have to view the lectures online and complete the assigned homework and exams. However, Moodle does not make it easy to find the due dates. Furthermore, the course schedule is always updating, and some of my instructors may not even tell me about it. Since that is the case, it's quite difficult to follow."

Students may have psychological pressures if they cannot adequately address the time management concerns mentioned above. One student experienced a range of unpleasant emotions due to the pressures of online learning and time management.

> "My time management is completely out of my hands. At the last minute, I finished and turned in all of my work. Away from home, I lack the drive I had at school. I wouldn't say I like studying and revising at home. No matter how hard I try, I just can't get any work done at home."

On the other hand, few participants accepted the positive aspects of the CBL environment. The convenience of taking classes from home and the resulting lower stress levels made taking online courses the preferred option. One of the participants reported as follows:

TABLE 4 The outcome of correlation analysis.

Items	Learning environment	Time management	Technical challenges	Teaching methods	Expectation	Quality of CBL environment
Learning environment	1					
Time management	0.79**	1				
Technical challenges	0.73**	0.79**	1			
Teaching methods	0.76**	0.71**	0.78**	1		
Expectation	0.80**	0.75**	0.75**	0.85**	1	
Qualityof CBL environment	0.75**	0.77%	0.80**	0.81**	0.92**	1

**$p < 0.01$.

TABLE 5 Relationship between independent and dependent variables.

Hypotheses paths	Standardized parameters	R^2
Learning environment -> Quality of CBL environment	16.83	0.56
Time management -> Quality of CBL environment	17.15	0.59
Technical challenges -> Quality of CBL environment	18.21	0.71
Teaching methods -> Quality of CBL environment	19.29	0.69
Expectation -> Quality of CBL environment	29.64	0.84

TABLE 6 Themes and sub-themes.

Themes	Subthemes	Description
Learning environment	Quality of teaching methods, Online assessment, and Content quality.	The participants shared their learning experiences in the CBL environment. They demand a practical session and require effective course material.
Time management	Complex assignments and video lectures, and Sharing knowledge.	The participants reported that the assignments were complex and lack of organized videos. However, they shared the resources and knowledge with other students.
Challenges	Technical and behavioral challenges, technology, internet connection, and digital skills.	Students experienced difficulties with internet connection and online learning tools. In addition, they require a training session for using the online tools.
Assessment	Grade, assessment metric, and interaction.	The participants demand an interactive assessment technique for grading their assignments.
Future preferences	State-of-the-art online tools, training sessions, and course material.	The participants require a flexible online tool for interacting with teachers to improve their knowledge.

> "Taking lectures online helped me save time and energy since I didn't have to deal with campus-based distractions like forced participation in events, adjusting to inescapable noise, and wasting time seeking a quiet area to concentrate."

4.3. Theme 3: challenges

Students offered many suggestions to improve online coursework. One way to improve classroom discussion is to provide more concrete examples. Some students complained that their instructors moved too quickly through the course and did not provide enough explanation or examples.

> "My instructor gave us some more instances to consider. The pace at which he is instructing is unsustainable."

The students had some difficulty and found specific barriers when taking online classes. There were several issues with the time and layout of online learning sessions and concerns about students' ability to adjust and interact with the new system. Some participants' perspectives on these topics were as follows:

> "Some of the lectures went on for an extremely long time. The lecturers never seemed to be serious about adhering to the allowed time. Unfortunately, not all lecturers arrived on time. Hence not all of them got their lectures started on time. Both day and night, there were a lot of lectures."

Students also reported dealing with technological challenges, such as poor internet connections, power outages, and trouble

getting into online courses. Many participants expressed the following remarks about the technical difficulties:

> "It used to be quite difficult to keep up with teachers during online lectures because of the many internet outages I experienced."
>
> "My involvement was severely hindered by technical difficulties, such as slow download speeds and intermittent connectivity to the internet, and by the lecturers' frequent absences. It was usual for online sessions to experience technical difficulties, such as distorted audio, due to heavy load on the underlying internet infrastructure."

Challenges with behavior and acceptance include resistant attitudes to new ways of learning. The following comments provide clear insight into how participants feel about the legitimacy of online education.

> "I faced some challenges and my family didn't know how seriously I was engaged in my online education."
>
> "Because of my online classes, I missed a lot of social activities. I never have time to do anything other than listen to lectures, and I've stopped talking to my classmates."

4.4. Theme 4: assessment

Students are concerned about the legitimacy of online examinations. Many students expressed that there is a higher incidence of disruptive behavior on online tests since they may be taken at home using a computer and an internet connection. It might be unfair to some students.

> "There is a legitimate worry about the fairness of online evaluations, and that's one of the things I want to share. A poor student may get the same grade as a brilliant student if he/she and another student can communicate or discuss while taking an online exam."

One way in which educators might facilitate students' success in online courses is through the use of more frequent assessments. Students believed it might encourage them to focus more in class and study independently. One of the excerpts is as follows:

> "Online learning and evaluations might be supplemented with brief quizzes designed to track student progress."

4.5. Theme 5: future preferences

It was discussed with the students whether to pursue online education or go back to classroom-based education. There were a variety of reactions expressed. Even though the vast majority favored online instruction, some students, particularly those in higher-level courses, wanted to keep attending traditional classrooms and taking part in actual experiences of practical-based methods. The following argument supports conventional classroom instruction:

> "I would request management to address the limitations of the CBL methodology. In my opinion, the campus and labs of a university are the best places to study because of the unique learning environment."

Some students appreciated the online learning experience but also made recommendations for improving the system if it is to continue. The following comments provide further explanation.

> "I would be interested in continuing online lessons if the technology can be completely reliable and ready for use when we restart. It's the technical side I'm referring to."
>
> "In the upcoming school year, I plan to only continue my online education in the areas of data science and database technologies."

5. Discussions

In this study, the author conducted a mixed-methods approach to investigate the students' performance in the CBL environment. The qualitative findings were validated using quantitative analysis. A set of five hypotheses were proposed to evaluate the students' perceptions of the CBL environment. A total of 104 students participated in this study and recorded their responses. Based on the study's objective, the author extracted themes and subthemes from the reactions. The participants demanded an effective course to improve their programming skills. The study result is similar to the results in the studies (Koskey and Benson, 2017; Lee-Post and Hapke, 2017; Brilingaite et al., 2018; Galan et al., 2019; Williams, 2019; Wong et al., 2019; Carrillo and Flores, 2020; Khalil et al., 2020; Yeung, 2020; Zhong, 2020; Curelaru et al., 2022; Yeung and Yau, 2022). However, the proposed study investigated the CBL environment. Many studies outline the role of CBL during the COVID-19 pandemic.

The exponential growth of IT applications requires a highly skilled individual to increase the productivity of an organization. The study findings suggest the importance of curriculum design, interface efficiency, and faculty knowledge for the thriving CBL environment. Furthermore, the core of Vision 2030 is based on three factors: a flourishing society, a prosperous economy, and an ambitious nation. The Vision is being realized through offering equal responsibility, making long-term investments, and developing a wealthy economy to improve individuals' quality of life. The Kingdom's digital transformation is the key focus of this primary initiative for realizing Vision 2030. Partnerships with public and commercial organizations offer strategic direction and knowledge and improve educational standards. The investment in young talent can support the government in improving the standards. The findings can support the educational institution in improving the students' learning environment.

The study's findings support the previous studies (Given, 2008; Kastanakis and Voyer, 2014; Dumford and Miller, 2018; Curelaru, 2021; Ensmann et al., 2021; Toader et al., 2021), suggesting

students are not attentive during virtual classes. They are distracted by the various forms of entertainment on mobile devices and computers. Some students reported IT problems that made it challenging to complete their coursework online. One research found that learning technologies largely determined students' satisfaction with their online education. Therefore, it is crucial to decide on specific IT issues in order to implement the appropriate solutions. This research showed two key concerns related to unreliable networks and device malfunctions. Some students may not have access to a reliable electronic gadget since they have to share it with a sibling to access educational resources online. Therefore, some students may have difficulty gaining access to computers. In line with the findings of other researchers, the author found that students still struggled to learn effectively using online platforms with few opportunities for student-teacher interaction. In particular, students have limited opportunities for direct instructor involvement and timely feedback. Some students used email as a learning tool when other options were exhausted. Thus, providing the facility for student-teacher communication and instructor feedback in online education is essential. In addition, teachers should be available to sort out the students' difficulties with online tools.

Furthermore, this research shows that written communication, such as emails, is not a preferred method of interaction between teachers and students in Saudi Arabia. Most students use Arabic for communication in KSA, and English as a second language may present limitations. According to the research findings, students preferred one-on-one sessions using audio communication through platforms such as Zoom, Google Meet, etc. This contact method is more personal and encourages students to express themselves in their preferred language. It is essential to highlight that the solutions above emphasize establishing communication between teachers and students. It is a crucial step in reducing the transactional gap to mitigate misunderstandings in communication. Course structure, student-instructor interaction, and student's level of independence are the critical determinants of transactional distance. There is a positive correlation between transactional distance and student autonomy. The CBL environment can reduce the transactional distance between them and their instructors by expanding opportunities for two-way communication. On the other hand, students and teachers will engage in a dynamic process through chatrooms and audio sessions, whereby the former share and negotiate meaning with the latter.

The students strongly preferred this form of interaction for the thriving CBL environment. An issue is that some students are lost in online learning and have given up trying to find solutions to the difficulties. The author discovered how other students utilized different Self-regulated learning (SRL) strategies to refine their learning abilities. The findings follow the existing research studies (Verderame et al., 2018; Onyema et al., 2019; Partovi and Razavi, 2019; Gallardo, 2020; Kononets et al., 2020; Nurtanto et al., 2020; Venkatesh et al., 2020) on the necessity of a time management schedule. Time management skills are invaluable assets for success in online education. Teachers should investigate the feasibility of incorporating such applications into the course, publishing and syncing the course's deadlines and reminders. Students demand a centralized interface for unified and thorough announcements. In addition, the students believe that the CBL environment is a better alternative to the traditional teaching environment.

Due to content being dispersed across several platforms, students become perplexed regarding the structure of their courses. Among the factors contributing to students' overall satisfaction with online education is the clarity of course expectations. Previous research (Mahasneh and Alwan, 2018; Onyema et al., 2019; Nurtanto et al., 2020) has indicated that instructors make frequent classroom announcements or send emails to remind students of important course information. However, this research shows that the consistency and regularity with which the instruction or notification is delivered are crucial. Since students may become confused and experience the psychological load of remembering knowledge if their professors use different portals to remind them, they demand a centralized interface for course notifications.

The majority of the participants had trouble adapting to online classes. There was a pervasive issue with inadequate technology, such as slow internet connections and a lack of computer literacy. The findings align with various studies (Sarker et al., 2019; Hewat et al., 2020; Lee et al., 2020). Integrating technology into computer education depends on the faculty's willingness and skill to effectively use it to improve teaching and learning. These skills cannot be taught in a traditional environment. Hence alternative methods are required. Therefore, it would seem that educational institutions would benefit from compulsory training for faculty in educational technology expertise.

Technological and socio-demographic variables influenced the participants' experiences, including their level and specialization. Quality control issues may slow down the institution's use of e-learning. According to the study, the online modules encourage cooperation between teachers and learners. A systematic and open institutional strategy is required to establish a system that may support organized techniques. Several respondents cited teachers' inability to use non-verbal signals as a significant hindrance to their education. According to communication theorists, while words convey verbal communication, non-verbal messages beyond the meaning of individual words often enhance what is being spoken (Modlo et al., 2019).

The teacher's body language significantly impacts the student's development of an emotional bond with them. Eye contact, gestures, and body language are all essential non-verbal clues facilitating communication. Finally, the lack of transition time from traditional face-to-face education to online learning may have contributed to negative impressions. Academic expectations of online synchronous learning, such as increased participation, building online communities, a sense of belonging, and other online social activities, were not well addressed by either students or teachers.

A total of 104 computer science students at Shaqra University were the subject of this research since they were transitioning from a lecture-based to a competency-based curriculum. Due to the small number of students analyzed within the specific curriculum, the research results are probably not transferable to other educational settings. Regarding the monitoring phase of SRL, there is a large difference between the learning techniques students use in traditional learning and what is required in a flipped

classroom model. Traditional learning helps students develop their learning strategies. Students have trouble integrating and synthesizing knowledge when they are not actively participating in cognitive monitoring as they proceed through autonomous work. The nature of the precise instruction that supports students in the CBL is still a topic of inquiry among educators. Students should be explicitly taught and practice new techniques whenever the learning framework shifts.

5.1. Limitations

The main limitation of this study is that it was conducted in a single institution. The author acknowledges that this modality may have additional possible benefits and drawbacks for undergraduate computing students, even though five primary themes and several subthemes arose from this study. The principles of the CBL environment results need to be examined carefully and often to guarantee the efficacy of online learning modules for undergraduate students. Larger, more evenly-scattered student samples from several institutions and locations should be used in future research. In this study, many students responded similarly to the several tasks because of the qualitative character of the assignments. A detailed context analysis is required to understand the student's technology adaptation. The author faced challenges in reaching a larger number of teachers and students. CBL concepts were difficult to translate into Arabic. As a result, the students may have not understood the CBL concepts effectively, which may have affected the results.

However, the research findings were used to suggest ways to improve online education, so that the quality of education is not compromised in the future.

6. Conclusion

Using thematic analysis, the author analyzed students' experiences with competency-based learning during the COVID-19 pandemic. The study's outcomes have theoretical and practical significance for emergency education since they show the effects of students' emotions and technological and socioeconomic status on several elements of their online learning. When teachers use a centralized portal to make announcements about their classes, students may feel less stressed about missing important dates. The study's results concur with other studies about the benefits of online education for computer science students. Therefore, primarily synchronous learning in the online module offers significant and promising potential for the future of computing education and may be implemented into the curriculum to increase the effectiveness of lifelong learning. Undergraduate computer education might benefit from further investigations to determine the most successful online and offline teaching methods and to develop a carefully thought-out strategy based on the best incorporation of online learning.

The findings showed that students with diverse learning habits had distinct CBE perceptions, contradicting the results reached by Yeung and Yau (2022) who hypothesized that CBE would be more readily noticed by process-oriented and student-centered educators than by more conventional educators. This study's findings revealed that educators' views on CBL principles are consistent, independent of the mode in which they provide instruction. This might be seen as an asset, as it suggests that all stakeholder groups of educators will be able to study the qualities and principles of CBL and then proceed to develop a suitable platform for CBL. Furthermore, student cooperation might be seen as a feasible technique for CBL development in the field of computer science based on the instructors' optimistic views of CBL. This study's finding is consistent with the outcome of Curelaru et al.'s (2022) study. According to the study findings, instructors had more favorable views of CBL concepts than students. Teachers often have a greater understanding of CBL, which allows them to identify elements of CBL already present in the curriculum. There is a dearth of studies in the CBL environment. IT professionals in education and system developers may enhance design and execution by learning students' system impressions. The most significant conclusion of this study is that students' opinions of the CBL environment were mostly impacted by how well it met their educational requirements and expectations. Students are more inclined to adopt a system if they feel it offers the appropriate features. On the other hand, if the system does not deliver the required functionality, users will go to alternative systems to fulfill their requirements. This implies school IT experts need to guarantee the CBL functionality meets students' demands. The teacher or other professionals who lead students to utilize the CBL environment have a significant impact on their attitudes and utilization.

The results revealed many critical aspects impacting students' perceptions and utilization of CBL. From this viewpoint, the results of this study contribute to research and practice and inspire future research. To refine the findings, future research might include diverse educational contexts and learning management systems. A future study might combine interviews with observations of students using Moodle learning management applications. This may provide additional user experience insights. The study recommends studying high secondary school students' IT demands in future user acceptability studies. Such a study might help developers improve learning management systems by addressing student demands, which is crucial to system acceptability. This might help educational IT personnel understand students' priorities. During the course of this research, the author noticed that students were nervous or "stressed" as a direct consequence of being always online. Some students may have trouble disconnecting (being offline) and separating school and leisure time. Thus, additional studies should examine the effects of information and communication technologies on students' health.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving human participants were reviewed and approved by Research Ethics Committee Approval, Shaqra

University, Number: ERC_SU_20220118. The patients/participants provided their written informed consent to participate in this study.

Author contributions

The author confirms being the sole contributor of this work and has approved it for publication.

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Conflict of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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