



# Students' Perception and Performance Regarding Structured Query Language Through Online and Face-to-Face Learning

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### Specialty section:

This article was submitted to  
Digital Learning Innovations,  
a section of the journal  
Frontiers in Education

**Received:** 04 May 2022

**Accepted:** 17 June 2022

**Published:** 05 July 2022

### Citation:

Elalouf A, Edelman A, Sever D,  
Cohen S, Ovadia R, Agami O and  
Shayhet Y (2022) Students'  
Perception and Performance  
Regarding Structured Query  
Language Through Online  
and Face-to-Face Learning.  
Front. Educ. 7:935997.  
doi: 10.3389/feduc.2022.935997

This study explores the Structured Query Language (SQL) learners' perceptions in online and face-to-face learning regarding the role of the instructor, clarity in lesson delivery and understanding, and concerns about the shift in learning mode. In parallel, we evaluate the performance of online and face-to-face SQL learners in the final examination. The COVID-19 pandemic has forced educational institutes to shift their activities online. Thus, online learning has been accepted during the pandemic and gradually evolving. The literature on online and face-to-face learning has evaluated limited variables. Yet, in online and face-to-face learning, critical parameters concerning the SQL learners' perceptions about the role of instructors have not been explored. The present study surveyed the final-year students learning medium-level SQL courses at Bar-Ilan University Israel and the College of Management Academic Studies Israel. Survey questionnaires included demographic information, online learning experience, online learning sources, and ten questions about the learners' concerns of shifting, effectiveness, adequate instructions, the lecturer's clarity during instruction, clear understanding of the lesson, instructor's tools, instructor's availability, satisfactory response, learning independence, and spending extra time in online and face-to-face learning, separately. This study included 102 online learners and 95 face-to-face learners. All the online learners used Zoom and WhatsApp, and the face-to-face learners used Gmail and WhatsApp. Both online and face-to-face learners were significantly satisfied with the lecturer's performance, especially with the clarity in lecture delivery, instructor availability, and satisfactory response from the lecturer. In addition, online learners agreed upon the effective way of learning, clear understanding of the lesson, independence, and spending extra time. In contrast, face-to-face learners were more satisfied with the tools of the lecturer and dissatisfied with the dependence on the lecturer. Female students attending face-to-face learning were more concerned about the shift in the mode of learning. Further, online learners performed better in written examinations and face-to-face learners in oral examinations. Notwithstanding, advancements are still required to redesign the online learning environment for critical thinking in higher education.

**Keywords:** COVID-19 pandemic, face-to-face learning, online learning, SQL, students performance

## INTRODUCTION

The World Health Organization (WHO) declared the coronavirus outbreak a global pandemic in March 2020 (Arora et al., 2021). The global pandemic has generated severe concerns among the education systems' stakeholders. According to a UNICEF report, more than one billion students from about 100 countries have suffered educational setbacks due to the closure of educational institutes (UNICEF, 2020). As far as the national educational systems have dealt with, COVID-19 is the greatest challenge faced to date (Yosef et al., 2021). Adverse effects of COVID-19 on education are the disruptions of learning, less access to research facilities, loss of jobs, and increased student burdens (Majeed et al., 2020). Lockdowns were imposed worldwide with the instructions of social distancing and restrictions on large social gatherings to prevent the virus's spread. Therefore, the educational system shifted from face-to-face to online learning to engage students in academic activities (Paudel, 2020). In Israel, educators expressed severe concerns about education during COVID-19. Google Scholar found about 41,000 publications with the keywords education, impact, and pandemic in Israel (Yosef et al., 2021).

In this challenging situation, information technology has lightened the way for learners to get their education through innovative learning management systems. Educators use IT solutions to teach and evaluate students' coursework. For optimal use of technology and efficient learning processes, teachers, students, and administrators worked hard to ensure the continuity of online learning (Khan et al., 2021). However, poor infrastructures such as the unavailability of the internet and inadequate digital management systems hampered online learning. Even so, adopting modern technology and improving digit skills is necessary to fulfill the educational loss (Crossley and McNamara, 2016). Previous literature has pointed out the genuine complications in subjects such as chemistry and mathematics since they demand special assistance (Bakker and Wagner, 2020; Rap et al., 2020; Waitzberg et al., 2020; Heyd-Metzuyananim et al., 2021). Poor infrastructure, awareness, planning problems, and applicable policies also complicate the aptitude for teaching scientific topics at universities in Israel (Methkal et al., 2021; Yosef et al., 2021).

Online learning is not a recent trend; it was known as distance learning back in the early 18th century. Online learning is a segment of distance learning in which internet-based synchronous and/or asynchronous education is offered. Live online sessions are offered in a synchronous form of education. While asynchronous online learning, which is more traditional than distance learning, allows students to access course materials at their own pace. In online learning, students can access real-time lectures through learning management systems and/or the recorded lectures for later viewing. In distance learning, teacher and student do not interact frontally. The innovative progress of distance learning has developed parallel to communication technology over the last 300 years (Kentnor, 2015). In contrast, face-to-face learning is synchronous and

real-time learning where instructors attend a real-time physical classroom with the students. In general, online learning is entirely offered over the internet, while face-to-face learning can be combined with online learning to support the learning process effectively (Watson, 2008; Chisadza et al., 2021; Segbenya et al., 2022).

Online learning is necessary for pandemic times, but paying attention to the traditional way of learning is also essential. Undoubtedly, online learning provides students with great flexibility because they can watch the recorded lessons repeatedly. It is an unfeasible service in the traditional learning model (Khalil et al., 2020). Nonetheless, recorded classes do not allow for questions or interventions. The student watches it and performs it unilaterally, so they do not have a chance to participate in real-time. However, students can share their screens during online classes to share their mistakes in real-time for learning purposes with teachers and fellows. Although, online learning might generate a sense of feeling left out among students who are not addressed during classes. Thus, students should be given time slots to discuss their problems with the teacher (Rapanta et al., 2020). Recently, the COVID-19 pandemic forced the prompt implementation of online learning. For instance, on March 17, 2020, all the K-12 schools in the Washington State of United States and the University of Washington halted face-to-face classes and started online learning (Calhoun et al., 2020).

Online learning also depends on the nature of the course, whether it can be quickly taught or understood. Learning technology courses such as Structured Query Language (SQL) is beneficial in online learning due to lesson concentration, shared learning, and complete practice. SQL is a declarative computer language for processing data. It describes what to perform and what not to while solving the problem. In SQL, various options allow retrieving and updating the data, focusing on essence rather than technique (Halperin et al., 2013). Previously, research revealed that a deep understanding of novices' common semantic mistakes when writing SQL queries would improve teaching and learning outcomes (Ahadi et al., 2015). The SQL language independence and power make it possible to retrieve complex portions simply. The language's extraordinary productivity makes it famous among programmers and non-programmers. The SQL language is taught as a technological course in academic institutions and laboratories where students can practice the material provided by their instructors (D'Auria Stanton, 2006).

Previous studies (Yavuzarslan et al., 2019; Lai, 2020; Ribaud, 2020; Tuparov and Tuparova, 2021) have evaluated limited parameters regarding the perceptions of online and face-to-face SQL learners. Yet, essential parameters regarding the SQL learners' perceptions about the role of instructors and performance evaluation in online and face-to-face learning remain unattended. Therefore, the present study aims to evaluate and compare the perceptions of online and face-to-face SQL learners regarding the (a) concerns about the shifts in learning modes, (b) effectiveness and understanding of the SQL course, (c) learning tools used by the instructor, (d) instructor role, and (e) independence. In parallel, this study

compares and correlates the performance of online and face-to-face SQL learners.

## LITERATURE REVIEW

Online learning is student-centered learning that allows students to be independent and search for additional resources to enhance their prospects. Meanwhile, face-to-face learning is teacher-centered, where students depend on their instructors. Students rely on the instructions and guidelines from the instructors (Roach and Lemasters, 2006; Gherheş et al., 2021). Students' attitudes toward interactive courses online and in-person are identical. A study of online and face-to-face learners concluded that both groups performed equally well in interactive courses. Success in face-to-face classes depends on regular attendance, whereas interactive classes hinge on completing interactive worksheets. Hence, face-to-face and online success result from curriculum structure, mode of delivery, and completion rate (Nemetz et al., 2017). Indeed, online learning is a flexible, efficient, cost-effective, and first-rate method (Bartley and Golek, 2004; Gratton-Lavoie and Stanley, 2009; Strayer University, 2020). However, the abrupt shift from face-to-face to online learning has tested the coping capacity of educational institutions and the adaptation of students and faculty (Almahasees et al., 2021). Online learning has brought an engaging way of learning that positively impacts faculty and students to overcome this health crisis.

Online learning played a substantial role during times of crisis. Thus, improving the technical infrastructure is imperative for schools, universities, and research centers (Nikdel Teymori and Fardin, 2020). A study investigating SWOT (strengths, weaknesses, opportunities, and threats) analysis of online learning suggested the requirement of information technology learning and training at the school level (Dhawan, 2020). Nevertheless, data privacy is a massive challenge in online learning despite the benefits. Therefore, faculty members and learners must receive special training on data privacy and cybersecurity (Luxatia, 2020).

The successive progress and substantial technological changes require amendments to the last decade's methodology, strategies, and education techniques in online learning (Almahasees and Jacomard, 2020). During the lockdown, education shifted online with proper planning to reduce the impact on the learning process (Gurukkal, 2020). Online learning has benefited students at the university level since theoretical courses were conveniently taught online. Yet practical courses require face-to-face learning practices (Isaeva et al., 2020; Siripongdee et al., 2020). In this regard, technological enterprises have developed several online platforms to integrate technology into all facets of life (McLoughlin and Lee, 2010; Englund et al., 2017; Santos et al., 2019). The most frequently used interactive online platforms are Zoom, WhatsApp, WeChat Work, Teams, Skype, and DingTalk (Almahasees et al., 2021). Regarding the use of online platforms for education, a study affirmed that 66.7% of the respondents had heard about

Zoom for online learning (Adeyeye et al., 2022). Another study confirmed that 92% of the respondents knew Zoom, Microsoft Teams, and Moodle before the shift to online learning (Jehad et al., 2020). Thus, students' awareness and knowledge of online platforms and tools positively impact the development of constructive skills in online learners (Baanqud et al., 2020).

Previous literature has reported positive perceptions and opinions of both students and teachers about online learning (Seok et al., 2010; Kulal and Nayak, 2020). Although teachers and students were comfortable with online learning for theoretical subjects, they had concerns for practical subjects (Kinney et al., 2012; Beck and Blumer, 2016). In this regard, a study reported the efforts of learners and instructors to encounter the challenges of workload, technology, compatibility, and digital competence. This study recommended hybrid education (online and face-to-face learning) for theoretical and practical courses (Adedoyin and Soykan, 2020). Previous research confirmed higher achievements (Zhang et al., 2006), improved analytical skills (Chen and Jones, 2007), academic success (Al-Qahtani and Higgins, 2013), achieving learning goals (Wilkowski et al., 2014), higher self-confidence (Kay and McKlin, 2014), and better performance (Thai et al., 2017) in online learners compared to face-to-face learners. Notably, medical students were satisfied with online learning (Al-Balas et al., 2020). In a study conducted in Malaysia, Shahzad et al. (2021) reported a substantial satisfactory correlation among online learners. In contrast, a significant satisfaction among face-to-face learners over online learners has been mentioned by Tratnik et al. (2019). The reported challenges in online learning were students' shyness to participate and a lack of social interaction. Nevertheless, students were encouraged to participate in online class activities (Pinto, 2020). In parallel, negative emotions such as anger, fear, and helplessness amongst online learners has been published by Butz et al. (2015).

Besides common factors such as learning models, teaching technology, student-teacher interaction, and course content, effective online teaching largely depends on the instructor's role (Wang et al., 2021). Various facilitation strategies and cloud computing tools successfully enhance students' understanding of course content in online learning environments, increase students' engagement, and inspire them to explore new knowledge (Martin et al., 2018, 2019; Xu et al., 2020). Multiple scaffolding strategies online can also improve students' learning outcomes (Mamun et al., 2020). Most studies investigating the role instructors play in student learning have focused on instructor performance, instructional support, and instructor innovation (Wang et al., 2021). Students' perceptions of the quality of differentiated support for learning are among the most significant components influencing their independent learning and motivation (Mamun et al., 2020). Instructors provide instructional support in online learning environments by providing clear instructions, explanations, and constructive and timely feedback using various scaffolding strategies (Martin et al., 2018; Mamun et al., 2020). Learning outcomes and satisfaction with instruction are strongly associated

with instructional support in asynchronous online courses (Yunusa and Umar, 2021).

Research on the impact of instructor innovation on student learning outcomes in online learning environments is limited. However, a preliminary study of an asynchronous online learning environment found that instructor innovation is positively related to student satisfaction (Lee, 2011). According to the literature, students' engagement and motivation can also be enhanced when appropriate e-learning strategies and skills are applied to online teaching (Xu et al., 2020). Effective online educators are essential to student success (Ali and Ahmad, 2020). Hence, teachers need to continuously acquire new skills and expertise to facilitate students' learning and improve performance (Martin et al., 2018). In addition, instructors must ensure positive interactions between learners and instructors at all levels, including learners-learners and learners-content/technology. They must also be capable of determining appropriate tasks and tests for each student due to their differences. Lastly, instructors' attitudes and mastering technology are critical for the effectiveness of e-learning and students' perceptions of e-learning environments (Wang et al., 2021).

Research on SQL courses includes a pilot study investigating the knowledge and skills of students learning introductory level SQL online and face-to-face. The study reported a significant preference of the participants for face-to-face learning. Interestingly, blended learners showed substantial performance with positive effects and improvements (Yavuzarslan et al., 2019). Another related study reported motivating learners to embrace the shift of SQL learning to online during the pandemic. Students were encouraged to participate in the SQL Challenge Game in an online class that was used to engage them in activities and improve their academic achievement. Such challenging games appealed to and helped the learners to perform better academically. Student participation in the SQL Challenge Game was high, and the game scores highly correlated with students' academic performance (Lai, 2020). A study at Brest University revealed that with the increase in students (from 35 to 119), it was challenging to teach SQL courses online to computer science students, so they had returned to classical learning. However, students' perceptions and performance were similar (Ribaud, 2020). A recent pilot study discovered higher final achievements with gamified training and assessment in online SQL learning (Tuparov and Tuparova, 2021).

## METHODOLOGY

This study evaluated the acceptability and effectiveness of online or face-to-face learning from two groups of students learning the SQL course online or in-class. The paper also examined the performance of the two groups in final examinations.

### Participants

This study considered final-year students of 2020 and 2021 learning medium-level SQL courses at Bar-Ilan University Israel and the College of Management Academic Studies Israel. The following participants were chosen because they were in their

last year of studies and had mastered medium-level SQL courses. Additionally, the same instructor taught both groups with the same syllabus. In 2020, online classes were conducted, while in 2021, face-to-face classes.

### Course

The SQL course was medium-level. The main topics in the SQL course were Entity Relationship Diagram, Basic Queries: select and from, using where, inner join, left and right joined and using group by and having with agg function, Union Query, and Sub Query: select, where, having, from.

### Study Design and Questionnaire

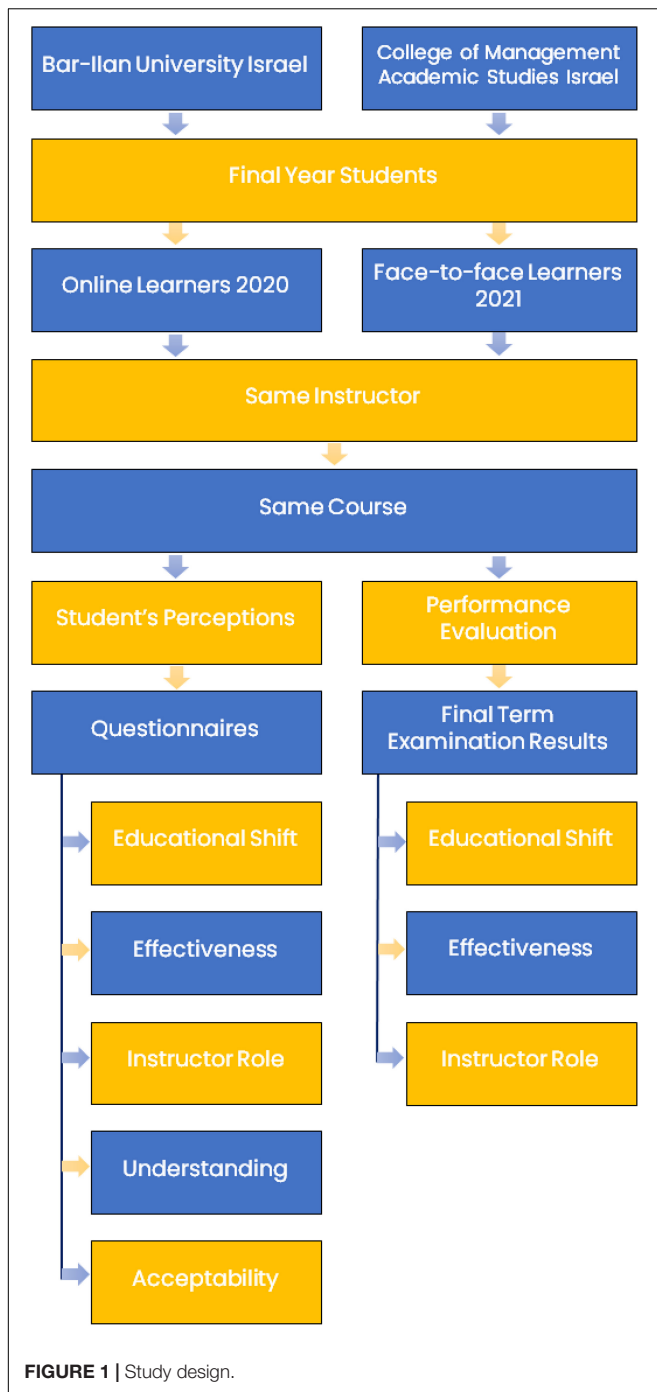
Two questionnaires (**Supplementary Material 1**) were prepared to evaluate the perceptions of online and face-to-face learners regarding educational shift concerns, effectiveness, understanding, acceptability, and role of the instructor in SQL courses in an online and face-to-face mode of learning. **Figure 1** depicts the study design. Due to the research gap in the literature regarding these parameters, questions were derived from the related studies (Roddy et al., 2017; Van Wart et al., 2020; Almahasees et al., 2021; Zalut et al., 2021). All the questions were rewritten in a more straightforward and explicit form. The questionnaires comprised different sections, including demographic characteristics, previous online learning experience, online learning sources, and ten questions to assess various parameters for online learning and face-to-face classes. The questions were formatted on five points Likert scale from strongly agree to disagree strongly. The questions estimated the students' concerns about the shift in learning methods, effectiveness, adequate instructions, the lecturer's clarity during instruction, clear understanding of the lesson, instructor's tools, instructor's availability, satisfactory response, learning independence, and spending extra time in online learning and face-to-face learning. The final term examination results were obtained to evaluate the students' online or face-to-face learning performance. The final exam papers were divided into three sections: 20 marks objectives included multiple-choice questions, 50 marks subjective had short questions and extensive questions, and 30 marks viva (oral examination), in which the instructor asked the students different questions relevant to the subject. Viva was conducted virtually *via* Zoom in online learning and frontal in face-to-face learning.

### Reliability and Validity

Two experts who examined cross-outs from both surveys validated the survey design. Some irrelevant items were omitted from the survey in response to their comments. The reliability of online and face-to-face learners' questionnaires was measured by Cronbach's alpha. The Cronbach's alpha value of both questionnaires was 0.7. The Cronbach's alpha value of responses  $\geq 0.7$  is considered acceptable (Bujar et al., 2019).

### Data Collection

An online Google Survey Form was used to survey online learning. In comparison, printed questionnaires were distributed



to face-to-face learners. The response rate of the participants was 100%. The final results were obtained from the examination office of both institutes with the subjects' permission.

## Statistical Analysis

The data were arranged in an excel spreadsheet, and statistical analysis was performed in SPSS version 21. Descriptive and inferential statistics were applied to the data. The responses to the questionnaires were categorical variables, and the final

examination results were numerical variables. The chi-squared test compared the categorical variables. The Shapiro–Wilk test determined the normality of the numerical variables. Wilcoxon signed-rank test compared the paired non-parametric variables of final examination result scores. Further, an independent-sample *t*-test compared the parametric numerical variables of total marks of online learners with gender and age. In contrast, Mann–Whitney *U*-test compared the non-parametric numerical variables of final examination result scores (full marks of online learners) with gender and age. Where required, Pearson's test correlated parametric data, and Spearman's test correlated non-parametric data. All the statistical tests were performed considering the 95% significance level at  $p \leq 0.05$ .

## RESULTS

This paper encompasses two groups, i.e., online learners and face-to-face learners of SQL learning. **Table 1** presents the demographic characteristics of both groups.

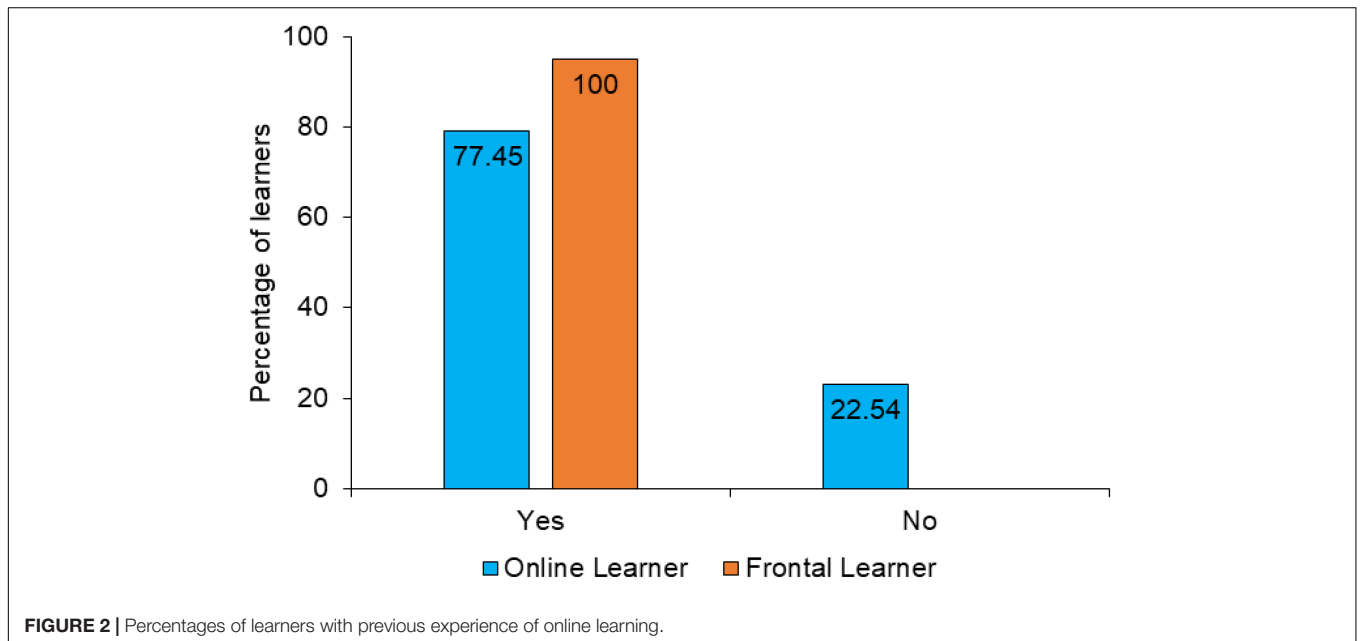
The survey includes 102 online learners (60, 58.8% males and 42, 41.2% females) with an average age of  $24.47 \pm 3.16$  years and 95 face-to-face learners (54, 56.8% males and 41, 40.2% females) with an average age of  $23.96 \pm 3.15$  years. **Figure 2** shows the percentages of previous online learning experiences of both groups. A comparative test was not conducted due to face-to-face learners' previous online learning experiences.

**Table 2** shows the number of students who used online platforms, internet sources, and devices during online and face-to-face learning. Zoom was used to deliver the class in online learning. Therefore, all the students selected zoom. All the online and face-to-face learners used WhatsApp for updates related to the class activities in both ways of learning. Additionally, Gmail was used by all face-to-face learners to submit assignments and other class activities. Most students of both groups used mobile data as an internet source. Laptops and mobiles were the most frequently used online and face-to-face learning devices. The chi-square test of independence insignificantly compared the association between the online and face-to-face learners in the use of online platforms, internet sources, and devices.

The students were asked to rate the different factors relevant to online and face-to-face learning. **Figure 3** presents the rating percentages of students for different factors in online learning. **Figure 4** displays the rating percentages of students for different factors in face-to-face learning. The chi-square test of independence showed a substantial association of online learners with learning effectiveness [ $1.91 \pm 1.12$ ,  $\chi^2(4) = 70.84$ ,  $p \leq 0.001$ ], lesson clarity [ $2.71 \pm 1.32$ ,  $\chi^2(4) = 23.68$ ,  $p \leq 0.001$ ], clear understanding of the lesson [ $2.14 \pm 1.02$ ,  $\chi^2(4) = 70.84$ ,  $p \leq 0.001$ ], instructor availability [ $2.3 \pm 1.05$ ,  $\chi^2(4) = 109.07$ ,  $p \leq 0.001$ ], satisfactory response [ $2.47 \pm 1.04$ ,  $\chi^2(4) = 26.43$ ,  $p \leq 0.001$ ], independence [ $2 \pm 1.04$ ,  $\chi^2(4) = 67.6$ ,  $p \leq 0.001$ ], and spending extra time for learning lesson [ $2.55 \pm 1.2$ ,  $\chi^2(4) = 43.1$ ,  $p \leq 0.001$ ]. In contrast, a significant association in the face-to-face learners were found with the lesson clarity [ $2.4 \pm 1.16$ ,  $\chi^2(4) = 21.36$ ,  $p \leq 0.001$ ], instructor tools [ $2.08 \pm 1.00$ ,  $\chi^2(4) = 65.36$ ,  $p \leq 0.001$ ],

**TABLE 1** | Demographic parameters.

Demographic parameters	Online learners <i>N</i> = 102, (% = 100)	Face-to-face learners <i>N</i> = 95, (% = 100)
<b>Gender</b>		
Male	60 (58.8)	54 (56.8)
Female	42 (41.2)	41 (40.2)
<b>Age (y)</b>		
Range	18–30	18–30
Mean ± SD	24.47 ± 3.16	23.96 ± 3.15
18–24	44 (43.1)	47 (49.5)
25–30	58 (56.9)	48 (50.5)

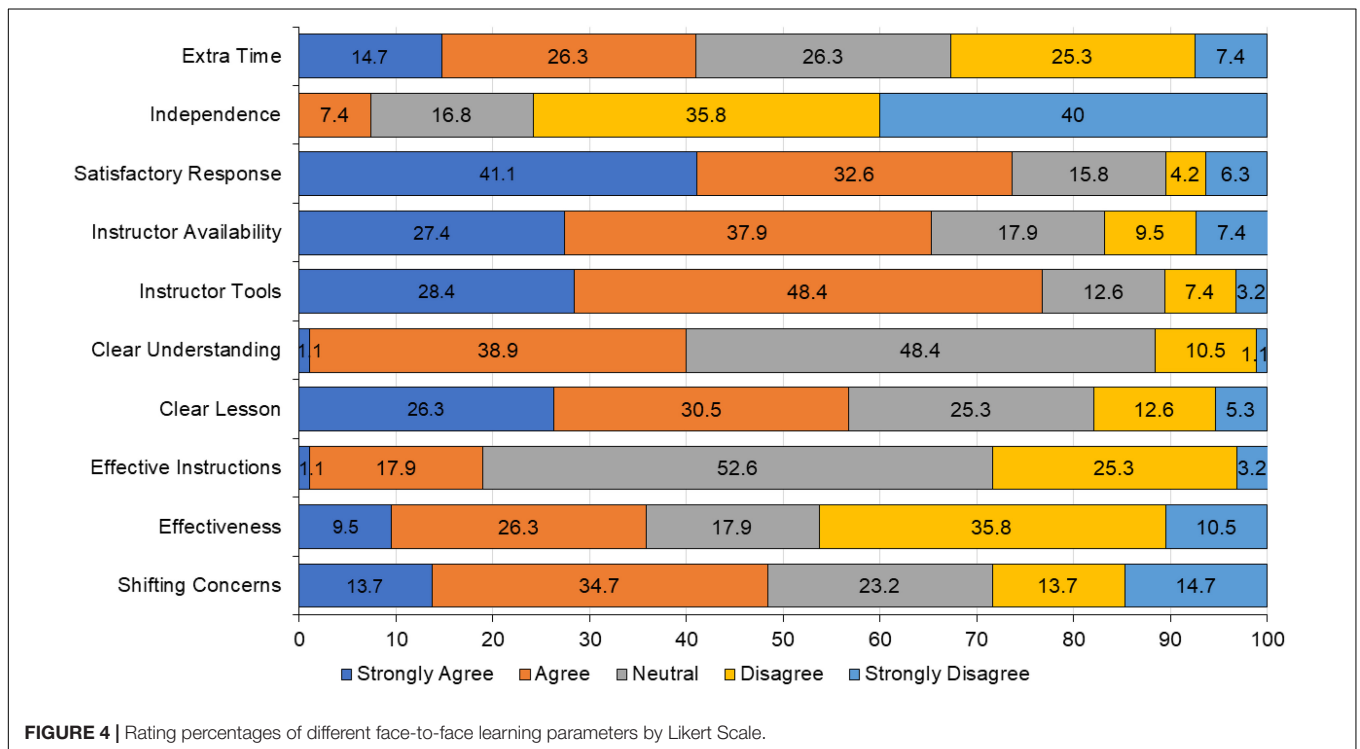
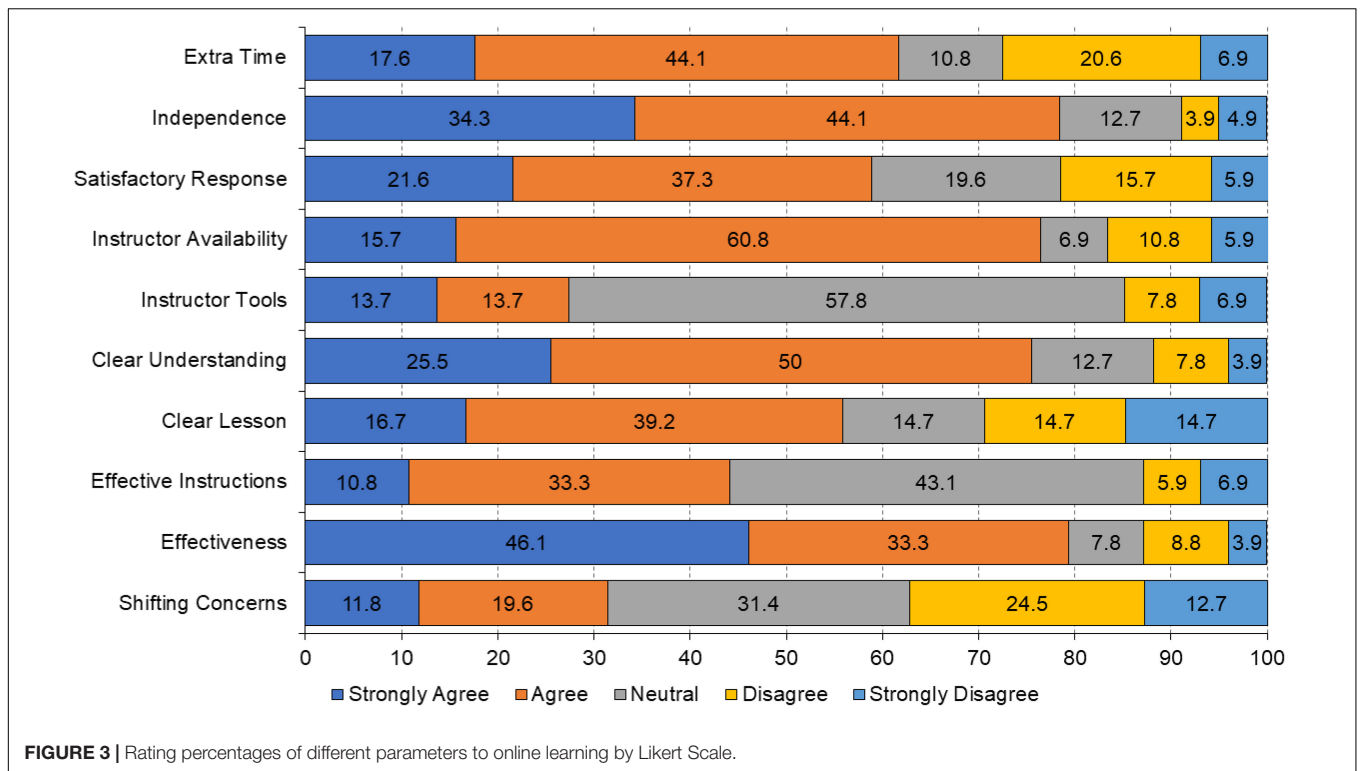


**FIGURE 2** | Percentages of learners with previous experience of online learning.

**TABLE 2** | Online platforms, internet sources, and devices used by online and face-to-face learners.

	Online learners		Face-to-face learners		Chi-squared	<i>p</i> -value
	<i>N</i>	%	<i>N</i>	%		
<b>Online platforms</b>						
Zoom	102	100	7	7.4	nc	nc
Google meet	13	12.7	11	11.6	0.347	0.556
WhatsApp	102	100	95	100	nc	nc
Gmail	24	23.5	95	100	nc	nc
YouTube	35	34.3	54	56.8	0.630	0.427
<b>Internet sources</b>						
Wi-Fi	67	65.7	39	41.1	0.039	0.843
Mobile Data	93	91.2	72	75.8	0.021	0.884
Landline	20	19.6	8	8.4	2.042	0.153
<b>Devices</b>						
Laptop	50	49	90	94.7	0.189	0.663
Computer	22	21.6	5	5.3	1.140	0.286
Mobile	95	93.1	48	50.5	0.132	0.716
Tablets	12	11.8	6	6.3	0.839	0.360

*nc* = not compared.



instructor availability [ $2.31 \pm 1.2$ ,  $\chi^2(4) = 30.84$ ,  $p \leq 0.001$ ], and the satisfactory response of the instructor [ $2.02 \pm 1.15$ ,  $\chi^2(4) = 50.2$ ,  $p \leq 0.001$ ] (Table 3). Interestingly, different online and face-to-face learning factors were found to be statistically

significant in the chi-square comparison test, as shown in Table 3.

Different important factors were compared with the demographic characteristics. Table 4 compares the demographic

**TABLE 3** | Comparison between online and face-to-face learning by various parameters.

Parameters	Online learning		Face-to-face learning		Chi-square	p-value
	Mean ± SD	Median	Mean ± SD	Median		
Shifting concerns	3.06 ± 1.2	3	2.81 ± 1.27	3	35.372	≤0.01
Effectiveness	1.91 ± 1.12	2	3.11 ± 1.19	3	55.860	≤0.001
Effective instructions	2.64 ± 0.99	3	3.11 ± 0.77	3	51.297	≤0.001
Instructor clarity	2.71 ± 1.32	2	2.4 ± 1.16	2	51.297	≤0.001
Clear understanding of the lesson	2.14 ± 1.02	2	2.71 ± 0.71	3	55.730	≤0.001
Instructor tools	2.8 ± 1.01	3	2.08 ± 1.00	2	55.925	≤0.001
Instructor availability	2.3 ± 1.05	2	2.31 ± 1.19	2	66.158	≤0.001
Satisfactory response	2.47 ± 1.17	2	2.02 ± 1.15	2	68.370	≤0.001
Independence	2 ± 1.04	2	4.08 ± 0.93	4	39.169	≤0.001
Extra time	2.54 ± 1.2	2	2.84 ± 1.18	3	39.373	0.001

characteristics and different parameters for online learning. The chi-square test of independence showed a significant association between gender and online learning effectiveness  $\chi^2(4) = 11.04, p \leq 0.05$ , lesson clarity;  $\chi^2(4) = 9.64, p \leq 0.05$ , and understanding;  $\chi^2(4) = 9.62, p \leq 0.05$ . However, a significant association between age and online learning effectiveness;  $\chi^2(4) = 10.27, p \leq 0.05$ , clarity in lesson understanding;  $\chi^2(4) = 17.82, p = 0.001$ , instructor tools;  $\chi^2(4) = 30.8, p \leq 0.001$ , instructor availability;  $\chi^2(4) = 13.73, p \leq 0.01$ , instructor satisfactory response in the class;  $\chi^2(4) = 18.82, p = 0.001$ , learning independence;  $\chi^2(4) = 25.69, p \leq 0.001$ , and spending of extra time for learning;  $\chi^2(4) = 51.62, p \leq 0.001$  were obtained by the chi-square test of independence. **Table 5** compares the demographic characteristics and important factors for face-to-face learning. A significant association was found only between age and student's concern of shifting the mode of learning;  $\chi^2(4) = 13.53, p \leq 0.01$ , and the satisfactory response of instructor;  $\chi^2(4) = 12.57, p = 0.01$ , during the face-to-face learning.

Pearson's correlation correlated different parameters for online and face-to-face learning. **Table 6** exhibits the significant correlation of various parameters between online and face-to-face learning. **Table 7** demonstrates the significant correlation of different parameters between online learning and face-to-face learning. The positive and negative correlations were calculated as  $p \leq 0.05$  significant correlation,  $p \leq 0.01$  very significant correlation, and  $p \leq 0.001$  highly significant correlation.

The results were used to evaluate the online and face-to-face learners' performance. **Table 8** indicates the comparison between examination results of online and face-to-face learners by the Wilcoxon Signed Ranks Test. Total marks, objective, subjective, and viva of online learners and face-to-face learners were compared to test for significance. **Table 9** compares the demographic characteristics (gender and age) and the final examination results of the online and face-to-face learners. The total marks of online learners were compared with an independent-sample *t*-test. The *t*-test found a significant difference between the age categories and the total marks of the online learners;  $t = -2.02, p = 0.05$ . In contrast, both learners' objective, subjective, and viva marks and total marks of face-to-face learners were compared with the Mann-Whitney *U*-test.

**Table 10** displays the correlation among the results marks of online and face-to-face learners. Parametric data were correlated with Pearson's test and non-parametric data with Spearman's test. The objective ( $r_s = 0.521, p \leq 0.001$ ), subjective ( $r_s = 0.53, p \leq 0.001$ ), and viva ( $r_s = 0.708, p \leq 0.001$ ) of online learners significantly correlated with the full marks of online learners. Similarly, objective ( $r_s = 0.774, p \leq 0.001$ ), subjective ( $r_s = 0.862, p \leq 0.001$ ), and viva ( $r_s = 0.505, p \leq 0.001$ ) of face-to-face learners significantly correlated with the full marks of the face-to-face learners. The subjective ( $r_s = 0.559, p \leq 0.001$ ) and viva ( $r_s = 0.213, p \leq 0.05$ ) results of the face-to-face learners showed a significant correlation with the objective and subjective of the face-to-face learners, respectively.

## DISCUSSION

Online learning was a feasible and preferable solution to save the education sector during the lockdown period. However, shifting the education mode from face-to-face to online was challenging. Learners and instructors faced numerous difficulties during the shifting process, as mentioned in different studies (Chen et al., 2020; Dilmaç, 2020; Mailizar et al., 2020; Rapanta et al., 2020; Dolenc et al., 2021). Despite the challenges, instructors and learners have adopted online learning perfectly. Yet, students still have concerns about the improper infrastructures, inexperience, and disorganization. Therefore, this study evaluated the SQL learners' concerns regarding shifting the mode of education.

No doubt, online learning is entirely internet-based. In comparison, face-to-face learning combines online learning, where students get help from internet sources (Watson, 2008; Chisadza et al., 2021; Segbenya et al., 2022). Herein, face-to-face learners also use online platforms, internet sources, and devices for communication and a better understanding of the topics (**Table 2**). All online learners used Zoom to attend the class and WhatsApp for class updates during the lockdown. This finding correlates with studies that found that Zoom and WhatsApp were frequently used in online learning (Bahasoan et al., 2020; Singh et al., 2020; Bina et al., 2021; Pandey et al., 2021; Suadi, 2021). In contrast, all face-to-face learners used WhatsApp and



**TABLE 4** | Comparison of demographic characteristics and different parameters for online learning.

Demographic characteristics	Strongly agree (N)	Agree (N)	Neutral (N)	Disagree (N)	Strongly disagree (N)	Chi-square tests	p-value
<b>Shifting concerns</b>							
Male	6	15	18	15	6	3.51	0.476
Female	6	5	14	10	7		
18–24	3	8	19	11	3	7.27	0.122
25–30	9	12	13	14	10		
Online learning experience	10	17	26	17	9	2.93	0.57
No online learning experience	2	3	6	8	4		
<b>Effectiveness</b>							
Male	35	18	3	3	1	11.04	≤ 0.05
Female	12	16	5	6	3		
18–24	22	9	5	7	1	10.27	≤ 0.05
25–30	25	25	3	2	3		
Online learning experience	36	28	4	7	4	5.1	0.277
No online learning experience	11	6	4	2	0		
<b>Effective instructions</b>							
Male	8	18	23	6	5	6.80	0.147
Female	3	16	21	0	2		
18–24	5	12	23	4	0	9.03	0.06
25–30	6	22	21	2	7		
Online learning experience	10	30	27	6	6	11.94	≤ 0.05
No online learning experience	1	4	17	0	1		
<b>Lecturer clarity during instruction</b>							
Male	14	26	8	5	7	9.64	≤ 0.05
Female	3	14	7	10	8		
18–24	3	21	8	7	5	7.23	0.124
25–30	14	19	7	8	10		
Online learning experience	15	29	11	12	12	1.95	0.745
No online learning experience	2	11	4	3	3		
<b>Clear understanding of the lesson</b>							
Male	21	29	5	4	1	9.62	≤ 0.05
Female	5	22	8	4	3		
18–24	4	31	6	3	0	17.82	0.001
25–30	22	20	7	5	4		
Online learning experience	22	34	11	8	4	8.03	≤ 0.05
No online learning experience	4	17	2	0	0		
<b>Instructor tools</b>							
Male	9	10	32	6	3	3.2	0.524
Female	5	4	27	2	4		
18–24	0	8	36	0	0	30.8	≤ 0.001
25–30	14	6	23	8	7		
Online learning experience	12	13	42	5	7	6.83	0.145
No online learning experience	2	1	17	3	0		
<b>Instructor availability</b>							
Male	12	37	3	5	3	3.48	0.48
Female	4	25	4	6	3		
18–24	6	34	0	4	0	13.73	≤ 0.01
25–30	10	28	7	7	6		
Online learning experience	9	48	7	10	5	7.41	0.115
No online learning experience	7	14	0	1	1		

(Continued)

TABLE 4 | (Continued)

Demographic characteristics	Strongly agree (N)	Agree (N)	Neutral (N)	Disagree (N)	Strongly disagree (N)	Chi-square tests	p-value
<b>Satisfactory response</b>							
Male	14	17	13	13	3	7.15	0.128
Female	12.9	22.4	11.8	9.4	3.5		
18–24	15	15	12	2	0	18.82	0.001
25–30	7	23	8	14	6		
Online learning experience	14	29	16	14	6	5.17	0.269
No online learning experience	8	9	4	2	0		
<b>Independence</b>							
Male	24	25	6	2	3	2.56	0.633
Female	11	20	7	2	2		
18–24	26	12	6	0	0	25.69	≤ 0.001
25–30	9	33	7	4	5		
Online learning experience	24	37	10	3	5	3.63	0.457
No online learning experience	11	8	3	1	0		
<b>Extra Time</b>							
Male	14	25	5	11	5	4.49	0.343
Female	4	20	6	10	2		
18–24	16	28	0	0	0	51.62	≤ 0.001
25–30	2	17	11	21	7		
Online learning experience	12	34	11	17	5	4.78	0.31
No online learning experience	6	11	0	4	2		

Gmail. WhatsApp was used for the class updates and Gmail for submitting assignments. As reported in a previous study (Selvaraj et al., 2021), all the online and face-to-face learners used WhatsApp because it is easy to use and a standard tool to communicate with the class and instructor. Most of the face-to-face learners (56.8%) watched additional YouTube tutorials to clarify the concepts compared to online learners (34.3%), as shown in **Table 2**. A study in Japan discovered that students who showed more interest in online learning used YouTube as a source of education (Winarni and Rasiban, 2021). Face-to-face learners used less internet compared to online learners. Further, most online learners used mobile (93.1%) for learning purposes. In comparison, 94.7% of face-to-face learners used laptops. Nevertheless, UNESCO reported that 706 million students did not have internet access, and about 826 million students did not have devices in their homes for online learning (UNESCO, 2020).

Previous studies reported improved skills, higher achievements, more success, self-confidence, satisfaction, and better performance among online learners (Zhang et al., 2006; Chen and Jones, 2007; Al-Qahtani and Higgins, 2013; Kay and McKlin, 2014; Wilkowski et al., 2014; Thai et al., 2017; Tratnik et al., 2019; Al-Balas et al., 2020; Shahzad et al., 2021). SQL is a learning technology declarative computer language course to perform and solve different problems by updating and retrieving the data (Halperin et al., 2013; Ahadi et al., 2015). Due to the computer-based learning of SQL courses, it is significant that online learners be more satisfied and independent. Herein, we found more satisfaction, comprehension, and independence in online learners. In contrast, face-to-face learners were pleased

with the instructor's tools, availability and response. Therefore, face-to-face learners were more concerned about the shift in the education model and most favored online learning (**Table 3**). However, studies that indicate students' preferences toward traditional education are also present (Hanafy et al., 2021; Selvaraj et al., 2021).

The study results showed that most males and females attending online learning remained neutral regarding the concerns of shifting the learning mode. In face-to-face learning, most males remained neutral, while females and students aged 18-24 showed concerns regarding shifting the mode of learning (**Tables 4, 5**). In parallel, the chi-square test of independence confirmed a significant association between gender and age in the effectiveness of online learning (**Table 4**). Similar results have been reported in the literature (Afrouz and Crisp, 2020; Butnaru et al., 2021; Dahnia and Sagala, 2021). In our study, both genders and age groups agreed on the effectiveness of online learning. However, most males agreed, and females disagreed with the effectiveness of face-to-face learning. Online learners were more independent than face-to-face learners (**Table 3**). A significant association between online learners' independence and age groups has also been confirmed, as shown in **Table 4**. Further, both genders and age groups of online learners agreed, and face-to-face learners disagreed with the independence parameter. However, most of the online learners agreed, and face-to-face learners remained neutral regarding the clear understanding of the lesson (**Tables 4, 5**). A previous study stated similar results related to the online learners' independence due to access to unlimited online data and flexibility in learning (Zabaniotou, 2021).

**TABLE 5** | Comparison of demographic characteristics and different parameters for face-to-face learning.

Demographic characteristics	Strongly agree (N)	Agree (N)	Neutral (N)	Disagree (N)	Strongly disagree (N)	Chi-square tests	p-value
<b>Shifting concerns</b>							
Male	9	15	17	6	7	7.17	0.127
Female	4	18	5	7	7		
18–24	7	23	11	3	3	13.53	≤0.01
25–30	6	10	11	10	11		
<b>Effectiveness</b>							
Male	4	16	11	15	8	5.94	0.203
Female	5	9	6	19	2		
18–24	1	15	10	19	2	11.03	0.026
25–30	8	10	7	15	8		
<b>Effective instructions</b>							
Male	1	10	27	15	1	1.94	0.747
Female	0	7	23	9	2		
18–24	1	11	21	14	0	7.4	0.116
25–30	0	6	29	10	3		
<b>Lecturer clarity during instruction</b>							
Male	12	19	12	8	3	2.63	0.62
Female	13	10	12	4	2		
18–24	15	14	12	5	1	3.15	0.532
25–30	10	15	12	7	4		
<b>Clear understanding of the lesson</b>							
Male	0	24	26	4	0	4.76	0.312
Female	1	13	20	6	1		
18–24	1	14	26	5	1	4.96	0.291
25–30	0	23	20	5	0		
<b>Instructor tools</b>							
Male	20	25	4	4	1	6.76	0.149
Female	7	21	8	3	2		
18–24	14	22	7	4	0	3.59	0.464
25–30	13	24	5	3	3		
<b>Instructor availability</b>							
Male	14	20	12	5	3	1.993	0.737
Female	12	16	5	4	4		
18–24	15	17	11	3	1	6.75	0.149
25–30	11	19	6	6	6		
<b>Satisfactory response</b>							
Male	26	15	8	3	2	4.4	0.354
Female	13	16	7	1	4		
18–24	15	21	9	2	0	12.57	0.01
25–30	24	10	6	2	6		
<b>Independence</b>							
Male	0	5	7	18	24	2.55	0.466
Female	0	2	9	16	14		
18–24	0	3	7	15	22	1.8	0.615
25–30	0	4	9	19	16		
<b>Extra time</b>							
Male	10	12	13	14	5	2.87	0.578
Female	4	13	12	10	2		
18–24	5	9	13	17	3	7.44	0.114
25–30	9	16	12	7	4		

In online and face-to-face learning, different factors correlated positively and negatively (Table 6). For instance, concerns about the educational shift among online learners positively

correlated with effective instructions, lecturer clarity during the instruction, and instructor tools. The effectiveness of online learning depends upon the well-preparedness of the

**TABLE 6** | Significant correlation of different parameters regarding online learning and face-to-face learning.

Parameters	Online learning				Face-to-face learning			
	Correlation	Parameters	Pearson's coefficient	p-value	Correlation	Parameters	Pearson's coefficient	p-value
Shifting concerns	Positive	Effective instructions	0.313	0.001	Positive	Clear lesson from the instructor	0.222	≤0.05
	Positive	Lecturer clarity during instruction	0.308	≤0.01	Positive	Satisfactory response	0.242	≤0.05
	Positive	Instructor tools	0.271	≤0.01	Negative	Extra time	-0.383	≤0.001
	Negative	Instructor availability	-0.254	0.01				
	Negative	Satisfactory response	-0.280	≤0.01				
Effectiveness	Positive	Lecturer clarity during instruction	0.610	≤0.001	Positive	Clear understanding of the lesson	0.246	≤0.05
	Positive	Clear understanding of the lesson	0.571	≤0.001	Positive	Instructor tools	0.288	≤0.01
	Positive	Instructor availability	0.400	≤0.001	Negative	Instructor availability	-0.466	≤0.001
	Negative	Satisfactory response	-0.237	≤0.05	Positive	Independence	0.475	≤0.001
	Positive	Independence	0.237	≤0.05	Positive	Extra time	0.334	0.001
Effective instructions	Negative	Clear understanding of the lesson	-0.392	≤0.001	Negative	Instructor availability	-0.224	≤0.05
	Negative	Instructor availability	-0.282	≤0.01	Negative	Independence	-0.3	≤0.05
	Negative	Satisfactory response	-0.212	≤0.05	Negative	Extra time	-0.485	≤0.001
Lecturer clarity during instruction	Positive	Clear understanding of the lesson	0.593	≤0.001	Negative	Instructor availability	-0.387	≤0.001
	Positive	Instructor tools	0.316	0.001	Positive	Satisfactory Response	0.514	≤0.001
	Negative	Satisfactory response	-0.443	≤0.001	Negative	Independence	-0.535	≤0.001
Clear understanding of the lesson	Positive	Instructor tools	0.227	≤0.05	Negative	Instructor availability	-0.329	0.001
	Positive	Instructor availability	0.211	≤0.05				
Instructor tools	Negative	Satisfactory response	-0.328	0.001	Negative	Instructor availability	-0.381	≤0.001
					Positive	Satisfactory response	0.548	≤0.001
Instructor availability	Positive	Extra time	0.288	≤0.01	Negative	Satisfactory response	-0.611	≤0.001
Satisfactory response	Positive	Independence	0.376	≤0.001	Negative	Independence	-0.264	0.01
	Positive	Extra time	0.203	≤0.05	Negative	Extra time	-0.250	≤0.05
	Positive	Extra time	0.575	≤0.001	Positive	Extra time	0.648	≤0.001
Independence	Positive	Extra time	0.575	≤0.001	Positive	Extra time	0.648	≤0.001
Extra time	Negative	Clear understanding of the lesson	-0.297	≤0.01	Negative	Clear lesson from the instructor	-0.207	≤0.05

**TABLE 7 |** Significant correlation between online and face-to-face learning according to different parameters.

Online learning	Correlation	Face-to-face learning	Pearson's coefficient	p-value	
Shifting concerns	Negative	Shifting concerns	-0.344	0.001	
	Negative	Instructor tools	-0.309	≤0.01	
	Negative	Satisfactory response	-0.320	≤0.01	
	Positive	Extra time	0.437	≤0.001	
Effectiveness	Positive	Effectiveness	0.312	≤0.01	
	Negative	Effective instructions	-0.212	≤0.05	
Effective Instructions	Negative	Effective instructions	-0.228	≤0.05	
	Positive	Clear lesson from the instructor	0.349	0.001	
	Positive	Satisfactory response	0.295	≤0.05	
	Positive	Extra time	0.260	≤0.05	
Lecturer clarity during instruction	Negative	Shifting concerns	-0.451	≤0.001	
	Negative	Satisfactory response	-0.357	≤0.001	
	Positive	Extra time	0.262	0.01	
Clear understanding of the lesson	Negative	Satisfactory response	-0.398	≤0.001	
Instructor tools	Negative	Shifting concerns	-0.397	≤0.001	
	Negative	Effective instructions	-0.281	≤0.01	
	Negative	Lecturer clarity during instruction	-0.447	≤0.001	
	Positive	Instructor availability	0.244	≤0.05	
	Negative	Satisfactory response	-0.504	≤0.001	
	Positive	Independence	0.424	≤0.001	
	Positive	Extra time	0.548	≤0.001	
	Instructor availability	Negative	Lecturer clarity during instruction	-0.409	≤0.001
		Negative	Satisfactory response	-0.304	≤0.01
	Satisfactory response	Positive	Shifting concerns	0.438	≤0.001
Negative		Effectiveness	-0.212	≤0.05	
Positive		Effective instructions	0.523	≤0.001	
Positive		Satisfactory response	0.267	≤0.01	
Negative		Independence	-0.415	≤0.001	
Negative		Extra time	-0.732	≤0.001	
Independence	Positive	Lecturer clarity during instruction	0.504	≤0.001	
	Negative	Independence	-0.459	≤0.001	
	Negative	Extra time	-0.407	≤0.001	
Extra time	Positive	Effectiveness	0.381	≤0.001	
	Negative	Extra time	-0.203	≤0.05	

**TABLE 8 |** Paired-wise comparison between examination results of online and face-to-face learners.

	Online learners (n = 102)		Face-to-face learners (n = 95)		Mean difference (Wilcoxon signed ranks test)	
	Mean	SD	Mean	SD	Z	p-value
Total marks	85.79	2.81	75.31	5.99	-8.27	≤0.001
Objective	17.45	1.19	15.13	2.49	-6.37	≤0.001
Subjective	46.47	1.53	37.42	3.50	-8.42	≤0.001
Viva	21.87	1.91	22.69	1.74	-3.21	0.001

instructors, clear instructions, and advanced technologies. Previous studies supported the findings of this study (Gilbert, 2015; Sun and Chen, 2016; Muthuprasad et al., 2021). In contrast, it negatively correlated with instructor availability and satisfactory responses. Online learners seem to encounter more difficulty facilitating effective learning situations where they are dissatisfied with the instructor's availability and

responses. As a result, faculty in these situations have difficulty engaging their students and may assume that these difficulties are related primarily to insatiable students (Dziuban et al., 2015). Concerns about the educational shift among face-to-face learners positively correlated with the following parameters: lecturer clarity during the instruction and the instructor's satisfactory response. On the other hand, it negatively correlated

**TABLE 9 |** Descriptive statistics with independent sample *t*-test/Mann-Whitney *U*-test compares the gender and age categories with examination results of online and face-to-face learners.

	Online learners						Face-to-face learners					
	Gender			Age			Gender			Age		
	Male (n = 60)	Female (n = 42)	Mean difference (t-test/Mann-Whitney U-test)	18-24 (n = 44)	25-30 (n = 58)	Mean difference (t-test/Mann-Whitney U-test)	Male (n = 54)	Female (n = 41)	Mean difference (Mann-Whitney U-test)	18-24 (n = 47)	25-30 (n = 48)	Mean difference (Mann-Whitney U-test)
Mean	SD	p-value	Mean	SD	t/Z <sup>a</sup>	Mean	SD	Z	Mean	SD	Z	
Total marks	85.65	2.92	0.54	85.16	2.85	-0.62	74.87	7.23	-1.02	75.73	4.51	-0.11
Objective	17.42	1.31	0.86	17.34	1.22	-0.18 <sup>a</sup>	14.70	2.77	-1.01	15.54	2.12	-1.23
Subjective	46.55	1.55	0.42	46.16	1.80	-0.82 <sup>a</sup>	37.15	4.04	-1.34	37.69	2.90	-0.20
Viva	21.68	1.95	0.25	21.66	2.13	-1.15 <sup>a</sup>	23.00	1.96	-0.54	22.40	1.45	-1.61

<sup>a</sup>Mean difference was calculated by Mann-Whitney U-test.

with spending extra time. Different factors also correlated with online and face-to-face learning (Table 7). Online learners negatively correlated with face-to-face learners regarding concerns about the shift in the mode of education, effective instructions, independence, and spending extra time. However, a positive correlation was found between the effectiveness and satisfactory response of the instructor in online and face-to-face learnings.

The final examination results helped evaluate the performance of online and face-to-face learners (Table 8). The performance of online learners was significantly higher in total marks, objective and subjective, compared to face-to-face learners. Similarly, studies have confirmed higher achievements, academic success, and better performance in online learners (Zhang et al., 2006; Al-Qahtani and Higgins, 2013; Thai et al., 2017). In contrast, face-to-face learners' viva results were significantly higher than online learners. The total marks for male and female online learners were almost similar; however, female face-to-face learners had slightly higher marks than males. Meanwhile, no significant differences were observed between the total marks, objective, subjective, and viva of males and females and age groups of both online and face-to-face learners (Table 9). Likewise, total marks of online and face-to-face learners were negatively correlated ( $r_s = -0.021$ ; Table 10). The mean difference ( $Z = 8.27, p = \leq 0.001$ ) of the total marks of the online learners was higher than the face-to-face learners (Table 8). One of the problems in online learning is cheating in examinations. This study's results indicate that online learners might have cheated in the objective and subjective portion of the exam due to their extraordinary marks. Meanwhile, face-to-face learners had higher grades in viva than online learners. The viva results confirmed a clearer understanding of the subject in face-to-face learners than in online learners. Such type of results denotes a chance of cheating amongst online learners. Hence, cheating reduces the significance of the evaluation system in online learning. Different studies have already reported the problem of cheating in online learning (Bilen and Matros, 2021; Rodriguez et al., 2021; Tarigan et al., 2021; Tiong and Lee, 2021). Different solutions have been proposed to detect and overcome this e-cheating, such as using a deep learning approach to monitoring the internet protocol and student behavior (Tiong and Lee, 2021). Further options are also considered, such as using a camera, lesser time, outlier detector, abnormal grades, and others (Bilen and Matros, 2021; Kamalov et al., 2021).

The rapid implementation of online learning has faced administration, technology, course activities' access, materials, and instructors' and students' communication problems. Despite extensive resource allocation and rigorous processes, it still constitutes a significant concern for many. However, all educational stakeholders have adapted to online learning instantaneously (Lockee, 2021). This study confirmed the system's rapid adaption, confidence, and approval. Online learning is now more accessible and widely available to the next generation. Thus, there is a clear path to implementation since students' performance can be enhanced by online learning.

**TABLE 10 |** Correlation of examination results of online and face-to-face learners.

Online learners		1	2	3	4	5	6	7	8
1. Total marks	Pearson's coefficient	1							
	<i>p</i> -value								
2. Objective	Spearman's coefficient	0.521	1						
	<i>p</i> -value	≤0.001							
3. Subjective	Spearman's coefficient	0.530	0.14	1					
	<i>p</i> -value	≤0.001	0.161						
4. Viva	Spearman's coefficient	0.708	0.127	−0.036	1				
	<i>p</i> -value	≤0.001	0.203	0.716					
<b>Face-to-face learners</b>									
5. Total Marks	Spearman's coefficient	−0.021	0.024	−0.076	0.049	1			
	<i>p</i> -value	0.84	0.814	0.466	0.64				
6. Objective	Spearman's coefficient	−0.018	−0.089	0.035	0.018	0.774	1		
	<i>p</i> -value	0.864	0.392	0.734	0.859	≤0.001			
7. Subjective	Spearman's coefficient	−0.09	0.061	−0.133	−0.006	0.862	0.559	1	
	<i>p</i> -value	0.385	0.557	0.198	0.952	≤0.001	≤0.001		
8. Viva	Spearman's coefficient	0.065	0.113	−0.105	0.109	0.505	0.146	0.213	1
	<i>p</i> -value	0.534	0.276	0.311	0.293	≤0.001	0.159	≤0.05	

Nevertheless, improvement in the evaluation process is a substantial requisite in online learning.

## LIMITATIONS

This study evaluated online and face-to-face SQL learners' perceptions regarding a few variables. The sample size was relatively small, and all the participants were medium-level SQL course learners at Bar-Ilan University Israel and the College of Management Academic Studies Israel. Hence, future studies should evaluate perceptions of other variables with a larger sample. Further, opinions of other education system stakeholders such as teachers and parents are required. To better understand this phenomenon and expand the database and quantitative research, the researchers intend to perform qualitative analyses and distribute a questionnaire to students nationwide. Apart from this, there are chances of e-chatting and barriers to learning practical courses in online learning. Therefore, further studies are required to find the solutions to the e-chatting and online practical courses.

## CONCLUSION

Online learning is preferable to save the education sector and continue learning during a health crisis. Rapid adaptation and acceptance of online learning have been scrutinized by investigating the students' success in the course. Nonetheless, the significance of face-to-face learning cannot be denied. This study discovered that online learners were more satisfied, comfortable, independent, accessible, and performed remarkably in the e-examinations. However, face-to-face learners were more satisfied with the instructor's tools and dissatisfied with the dependence on the instructor. Online learners performed excellently in written examinations, while face-to-face learners

performed excellently in oral tests. Hence, online learning is substantial for future education but needs advancements for redesigning and reimagining to develop an online learning environment for critical thinking in higher education.

## DATA AVAILABILITY STATEMENT

The original contributions presented in this study are included in the article/**Supplementary Material**, further inquiries can be directed to the corresponding author.

## ETHICS STATEMENT

The study involving human participants was reviewed and approved by the Ethics Committee of Bar-Ilan University, Israel. Written informed consent to participate in this study was not required from the participants in accordance with the national legislation and the institutional requirements.

## AUTHOR CONTRIBUTIONS

AEl conceptualized, drafted, supervised, analyzed the study, and finalized the questionnaires. AEd, DS, SC, RO, OA, and YS surveyed the literature review, collected the data, and wrote the manuscript. All authors contributed to the article and approved the submitted version.

## SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/feduc.2022.935997/full#supplementary-material>

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