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Enhancing sustainable development in education: Reality of cloud computing applications in activating e-learning at King Faisal University

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Abstract

After the outbreak of the COVID-19 pandemic, the world turned towards intensifying the implementation of modern educational technologies in general, especially those related to remote teaching and learning. These technologies have proven to save learners considerable time and effort, particularly in emergencies that necessitate a shift from traditional to remote education systems. They offer easy and secure methods for remote teaching and learning. One of the most significant modern technologies in this context is cloud computing, a term that refers to on-demand access to computer resources and systems over the network. Cloud computing can deliver a range of integrated computer services without being constrained by local resources, aiming to facilitate user interaction. The successful use and integration of cloud computing applications in educational institutions are key indicators of achieving outstanding educational quality. This includes attaining the highest possible levels of sustainable development competencies in education. The effectiveness of utilizing these applications is contingent upon the proper management of educational technology applications and their flexible and rapid activation from any location through the Internet. Therefore, this study aimed to assess the current utilization and deployment of cloud computing applications in activating e-learning at King Faisal University and provide insight into realizing the desired outcomes of implementing one of the most crucial e-learning technologies as a means of achieving sustainable development in education. This was accomplished by identifying the problems and challenges facing the use and deployment of this technology in educational institutions in the Kingdom, specifically at King Faisal University. Additionally, the study aimed to propose ways to enhance the utilization of certain applications utilizing this technology in e-learning within educational institutions.

Keywords: Sustainable development, Education, Cloud computing, E-learning

1. Introduction

University e-learning is expected to provide services for faculty members and educational opportunities for undergraduate and postgraduate students, contributing to the enhancement of quality in scientific, cultural, and educational activities. Additionally, it facilitates avenues for continuous learning and sustainable development

in education, aiming to stimulate students towards self-directed learning through the provision of necessary electronic tools and modern educational technologies.

At the beginning of the twenty-first century, the impact of the telecommunications and information revolution became evident worldwide. Since then, the field of education has witnessed a massive cognitive and technological revolution, resulting in numerous modern technologies that have significantly saved human time and effort. These technologies provide capabilities that individuals, institutions, and companies can leverage, particularly in the field of education [1].

One of these modern technologies is known as cloud computing, a term that refers to computer resources and systems available on demand over the network. Cloud computing can deliver a variety of integrated computer services without being constrained by local resources, to facilitate user tasks. These resources include data storage space, backup, and self-synchronization, as well as programming and task scheduling capabilities, remote email delivery, and printing. Users can control these resources through a user-friendly API when connected to the network, simplifying task execution and abstracting many of the details and programming operations that occur in the internal background [2].

At present, successful educational institutions have embraced the adoption and utilization of modern teaching technologies, including cloud computing applications. When managed, these applications provide a great deal of flexibility and speed in accomplishing educational tasks at any time and from any location through the Internet. This is in conjunction with other educational technology applications. This research focused on cloud computing and e-learning technologies, addressing the problems and challenges facing their use and achieving effectiveness in deploying these technologies in, and specifically at King Faisal University, Saudi Arabia. The aim is to enhance the effectiveness of their utilization in the e-learning environment. Accordingly, we believe that the university must ensure the provision of some material resources for education, especially concerning e-learning [3] [4].

The use of the internet has expanded tremendously in the past few years, thanks to the proliferation of tablets and smartphones after being initially limited to personal computers. Despite this widespread use, a lack of awareness was observed among some users regarding the optimal utilization of the internet, particularly in terms of cloud computing. The internet has become one of the risks threatening our societies due to a lack of awareness among some users in general [5].

With the evolution of technology, concepts of cloud computing, especially cloud storage, have become increasingly prevalent. In cloud storage, internet service companies provide users with free or officially subscribed storage spaces, catering to both individuals and organizations. This enables users to store their data, shifting data storage from local or personal devices to databases, representing a third party in what is known as cloud computing [6].

The use of cloud computing is not limited to storage alone; it has evolved into an integrated working environment that provides numerous services for companies and organizations without the need for significant expenses on hardware, equipment, and large workforces. It also offers enhanced security and rapid service delivery. For example, a large number of applications are available that provide quick and highly flexible access to information and data [7].

The results of the survey study on the digital content platforms market in the Kingdom of Saudi Arabia, [8] revealed that some educational institutions might lack a clear and integrated strategy for the use and coordination of cloud computing applications in general and particularly in the educational field. Despite some efforts from research studies by the Ministry of Communications and Information Technology, there are still obstacles facing some institutions, whether material or related to infrastructure. There may also be duplication of resources and constraints in the shared budget, in addition to the possibility of a lack of integration between institutions and insufficient awareness regarding cyber security and its importance in data protection. Based on the findings of the previous study report and the potential repercussions of weaknesses in the strategy for using and

coordinating cloud computing applications, the reason behind this may lie in the lack of awareness among many educational institutions, faculty members, and students about how to optimize the use of available cloud computing applications.

Based on the above, the main research question was: "What is the current reality of using and deploying cloud computing applications in activating e-learning at King Faisal University?"

This research's main question branches out into three sub-questions:

1. What are the key advantages of using cloud computing applications in e-learning at King Faisal University?
2. To what extent are cloud computing applications utilized in e-learning at King Faisal University?
3. How can challenges and difficulties in using cloud computing applications in e-learning at the university be addressed?

The present study relied on a questionnaire consisting of several questions, which was administered to a sample of faculty members and students at King Faisal University. The aim was to understand the current reality of using cloud computing in education, identify the main challenges and difficulties faced by participants, and determine whether these technologies are employed in a manner that enhances sustainable development competencies in e-learning or not.

The questionnaire used in this study covered three dimensions; each including a set of questions, to address the study's research questions.

The term "cloud computing" refers to computer resources and systems available on demand over the network. These resources and systems are expected to provide a variety of integrated computing services without being restricted by local resources, aiming to facilitate user access. These resources encompass data storage, backup, self-synchronization, software processing capabilities, task scheduling, remote email delivery, remote printing, the use of educational applications, class management, interactive test training, and displaying results with high speed, and precise control. When users are connected to the network, they can control these resources through an easy-to-use application programming interface (API), simplifying the utilization of resources and overlooking many of the details and programming operations taking place in the background [9].

The classification of cloud computing models based on data and information deployment includes four models:

a. Public Cloud Model (Public Cloud): In this model, the cloud infrastructure is made available for public use, and its ownership and management may belong to an official organization. It is typically hosted on the premises of the service provider.
b. Private Cloud Model (Private Cloud): This model is dedicated to a specific entity or organization, hosting the cloud infrastructure to provide applications and data for the participants of that entity [10].
c. Community Cloud Model (Community Cloud): In this model, services are shared among several organizations with similar information needs, and these organizations collaborate to share the associated costs [6].
d. Hybrid Cloud Model (Hybrid Cloud): This model involves a mixture of two or more different cloud models. It is used to leverage resources to enhance the efficiency of the core cloud, achieving this by offloading secondary tasks to the cloud and monitoring the core operations through the private cloud [11].

Cloud computing is classified based on its operational model into several types, including Autonomic Computing, which represents self-managing computer systems. The Client-Server Model is a widely used term in distributed applications, distinguishing between service providers (servers) and service consumers (clients or customers). Next is the Network Cloud model, representing an image of distributed and parallel computing. It consists of a virtual or giant computer composed of interconnected and loosely coupled computer devices

working harmoniously to perform massive tasks. The Utility Computing model refers to the process of provisioning computing resources, including computing and storage, as a scalable service similar to traditional public utility services like electricity. Lastly, the Service-Oriented Programming model provides mutually interrelated services. Service-oriented programming comprises computational methods that operate on software as a service (SaaS) [12].

Cloud computing provides several services, categorized based on the beneficiary's demand. One of the most popular and straightforward service types is Software as a Service (SaaS). This service is used automatically, developed according to end-users needs, and allows users to interact with network applications without the need for installation on their personal computers. The applications are hosted, managed, and updated by the service provider, ready for end-user use through the cloud. Another service is Platform as a Service (PaaS), where the service provider offers users, an environment containing programming tools and development languages. Users can develop and deploy applications for personal use or allow others to use them through this environment. Lastly, Cloud Computing offers Infrastructure as a Service (IaaS), allowing users to rent resources such as server storage space, memory, central processing units, and network connectivity equipment, all adjustable according to user needs, with costs based on usage. Additionally, there are other common services such as Email Services, well-known among internet users and provided by companies like Gmail, Yahoo Mail, and Hotmail. Cloud Storage is another service, offering online storage capacities for files without the need for physical storage units on the user's device or company [13][14].

Due to the increasing number of high school graduates and the limited capacity of governmental universities to accommodate them, the official capacity of these universities has reached 40% of graduates. This has led to the search for ways to increase the capacity to accommodate the growing number of students in universities and colleges. Consequently, there is a need for high-quality standards in the field of education and e-learning, especially in terms of technical quality standards and their applications in education. This may include opportunities for distance learning to accommodate a larger number of high school graduates, thus increasing the official capacity of universities. This initiative aims to attempt to absorb high school graduates and provide them with opportunities for studying within the country. Alongside this, there is a wide variety of universities and colleges in the Middle East, as determined by education ministries throughout the academic year [5].

Handoyo and Anas conducted a study to clarify the impact of advanced technologies as challenges facing education in the era of the new millennium. Its results affirmed that the distinctive nature of the millennial generation necessitates educational institutions to respond in a manner that meets emerging needs by integrating educational technologies into teaching methods [16]. In a study by Soka and Miroslav, the importance of adopting an ascending approach to education reform and the role of cloud computing applications was emphasized. The authors indicated a positive impact of effective utilization of cloud applications in reducing the cost of traditional programs and class hours, thereby attracting a larger number of students [17]. Another study by Parra, Jacobs, and Trevino aimed to provide students with practices using Google Sheets models under the supervision of faculty members through educational YouTube videos [19]. Its results pointed to the provision of opportunities to enhance student's skills in utilizing cloud computing and its effectiveness in education.

Mohamed conducted a study to elucidate the impact of cloud computing usage on enhancing and developing higher education in Egypt [20]. The study employed a survey methodology to collect data and found that the use of cloud computing contributes to the spread and improvement of higher education in general. It also worked on developing professional and technical skills for students, emphasizing that the lack of technical skills among many faculty members and students was a significant obstacle in this field.

Ben Youssef and others emphasized the importance of implementing cloud computing in educational institutions, continuously developing it to enhance its effectiveness in raising the educational quality for achieving better educational and research services at the lowest possible cost and highest quality [21]. Moreover, Doha Khaled et al confirmed that the importance of employing technological innovations in educational science

is linked to overcoming the challenges facing the educational process [22]. Cloud storage plays a crucial role in distance education. The study recommended more research on the use of cloud computing and its various applications, such as cloud storage, in distance learning programs and the field of e-learning in general.

In summary, the optimal application of electronic cloud services represents a convergence point where various educational services integrate, serving distributed learners across different locations with diverse and varied tools and equipment [18].

Previous studies emphasized the importance of leveraging cloud computing applications in education, particularly in providing diverse opportunities to enhance technical skills for faculty members and students. This, in turn, leads to the improvement of the overall education process. Therefore, this study might contribute to the increase of awareness within educational institutions about the significance of using cloud computing for faculty members and students in e-learning, potentially yielding effective outcomes within educational institutions, striving towards achieving sustainable development in education.

2. Research method

This section provides a detailed overview of the study methodology, offering a description of the study's objectives, approach, and research instrument.

2.1. Objectives

This study aimed to achieve the following objectives:

a. Identify the role of cloud computing in the overall development of institutions, with a specific focus on educational institutions.

b. Explore the advantages of utilizing cloud computing in enhancing e-learning in universities.

c. Examine the extent of using cloud computing applications in e-learning within universities.

d. Determine the role of educational institutions in addressing challenges and difficulties in effectively implementing and utilizing cloud computing applications in e-learning.

2.2. Methodology

This study adopts a descriptive methodology that fits its nature. A questionnaire was designed to assess the extent of usage and deployment of cloud computing applications by students and faculty members in universities. The questionnaire aimed to assess their awareness of the various applications, assess their utilization for enhancing e-learning, and explore the extent to which they leverage technological educational applications facilitated by cloud computing. The goal was to enhance sustainable development competencies in education at the university level. A stratified random sample was selected, including faculty members and students from both undergraduate and postgraduate levels at King Faisal University. The sample comprises 35% faculty members and 65% students.

The questionnaire was constructed by drawing on certain phrases from previous studies and adapting them to align with the current study's direction and its community. The questionnaire consisted of two main sections. The first section collected personal information, while the second section included three axes, as follows:

a. Dimension 1: Advantages of using cloud computing applications in e-learning, consisting of 10 statements.
b. Dimension 2: The degree of usage and deployment of cloud computing applications in e-learning, including 12 statements.
c. Dimension 3: Barriers to using cloud computing applications in e-learning, encompassing 8 statements.

The closed-ended format was adopted in preparing the questionnaire, which determined the possible options for answering each item by using a five-point Likert scale, with the score distribution as shown in Table 1. To verify the questionnaire's validity, correlation coefficients were calculated between the average of each dimension and the overall average of the items. The Pearson correlation coefficients ranged from a minimum of 0.765 to a maximum of 0.804. The correlation coefficients between all items of the questionnaire ranged from 0.700 to 0.824. The reliability of the questionnaire was assessed using Cronbach's alpha reliability coefficient, which was found to be 0.823. These results indicate that the questionnaire was of appropriate levels of validity and reliability.

Table 1. Likert scale response categories

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

3. Results and discussion

One hundred questionnaires were distributed to several colleges at King Faisal University in the Kingdom of Saudi Arabia. The sample included faculty members and students. 75 questionnaires were returned, and the data were analyzed using a Likert scale to determine participants' responses to the questionnaire. The statistical analysis results are summarized in Table 2.

Table 2. The result of the analysis

Q_1	**Q_2**	**Q_3**	**Q_4**	**Q_5**	**Q_6**	**Q_7**	**Q_8**	**Q_9**	**Q_10**	**Q_11**	**Q_12**	**Q_13**	**Q_14**	**Q_15**
4.19	4.00	4.00	3.92	4.06	4.13	3.48	3.50	3.12	4.18	4.22	3.56	3.64	4.06	3.00
5	5	4	4	4	5	4	4	4	5	5	3	4	4	3
0.8	1.0	*0.8*	*0.8*	*0.8*	*0.8*	1.0	1.4	1.4	*0.8*	*0.8*	1.0	1.2	*0.8*	*0.8*
0.1	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.2*	*0.2*	*0.1*	*0.1*	*0.1*	*0.2*	*0.1*	*0.1*
Q_16	**Q_17**	**Q_18**	**Q_19**	**Q_20**	**Q_21**	**Q_22**	**Q_23**	**Q_24**	**Q_25**	**Q_26**	**Q_27**	**Q_28**	**Q_29**	**Q_30**
2.56	2.48	3.96	3.50	4.56	3.43	2.33	4.31	4.42	2.13	2.66	4.00	3.97	3.64	3.92
2	2	4	3	5	3	2	4	5	1	3	4	5	4	4
1.3	*1.2*	*0.8*	1.0	1.4	1.0	*1.3*	1.4	*0.8*	*1.3*	1.0	*0.8*	1.4	1.2	*0.8*
0.2	*0.2*	*0.1*	*0.1*	0.2	*0.1*	*0.2*	0.2	*0.1*	*0.2*	*0.1*	*0.1*	*0.2*	*0.2*	*0.1*

3.1. The first dimension statements (advantages of using cloud computing applications in e-learning):

Q1. *Cloud computing applications facilitate easy and accessible learning materials.*

The majority of respondents expressed very high agreement, affirming that cloud computing applications provide easy and seamless access to educational materials. This indicates the presence of a significant advantage in the accessibility of cloud computing applications and their complementary technological services in university e-learning, as shown in Figure 1.

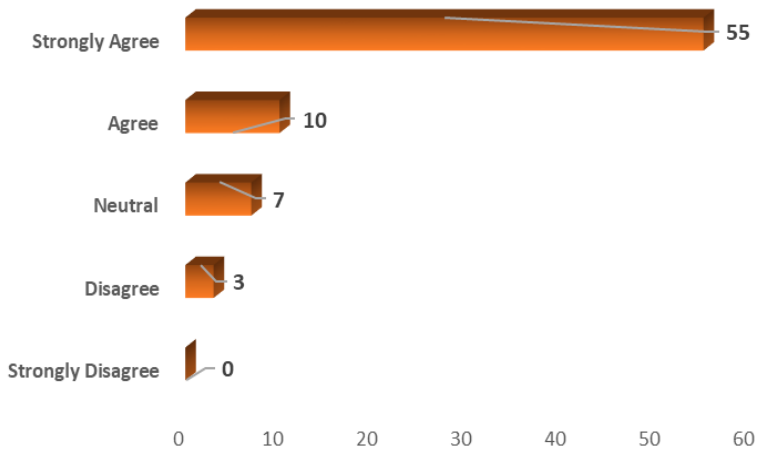

Figure 1. The result of question 1

Q2. *Cloud computing applications provide versatile and flexible learning environments that align with available teaching technologies*. A significant percentage of respondents strongly agreed that cloud computing applications provide diverse and flexible learning environments that align with available teaching technologies. A small percentage disagreed, which may be attributed to their limited experience with cloud computing applications, as shown in Figure 2.

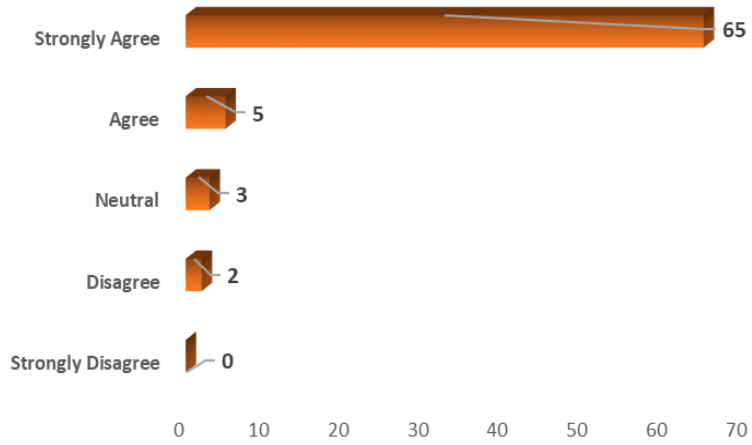

Figure 2. The result of question 2

Q3. *Cloud computing applications enable faculty members to configure diverse learning scenarios for use in teaching students*. The percentage of those who agreed that cloud computing applications allow faculty members to configure diverse educational scenarios was high, attributed to the variety of available applications at the university, as illustrated in Figure 3.

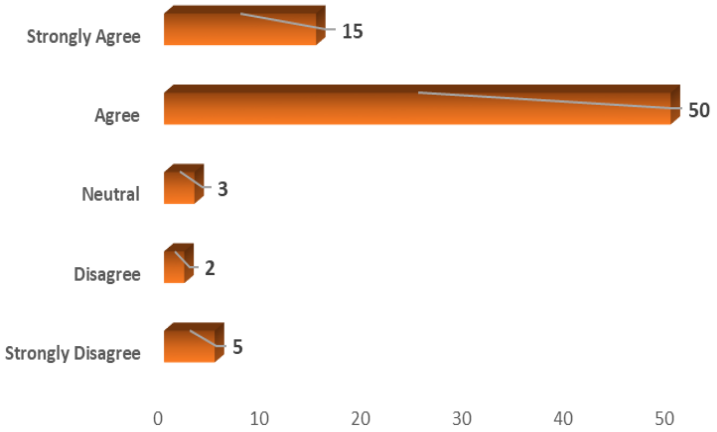

Figure 3. The result of question 3

Q4. *Cloud computing applications provide an electronic learning environment that emphasizes student participation in the execution of educational tasks, with supervision and guidance from faculty members*. A significant number of faculty members and students affirmed their agreement regarding the effective contribution of cloud computing applications in engaging students in the execution of educational tasks. This underscores the existence of active student participation through the use of these applications, as depicted in Figure 4.

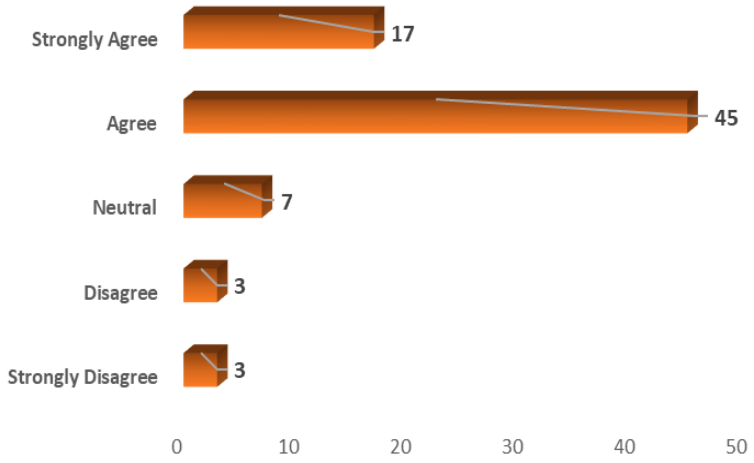

Figure 4. The result of question 4

Q5. *Cloud computing applications provide an interactive electronic environment that stimulates students to engage and participate during the instructional scenario*.

A high number of respondents confirmed their agreement that cloud computing applications provide an interactive electronic environment. This is attributed to the availability of tools for participation and interaction in the instructional scenario, as shown in Figure 5.

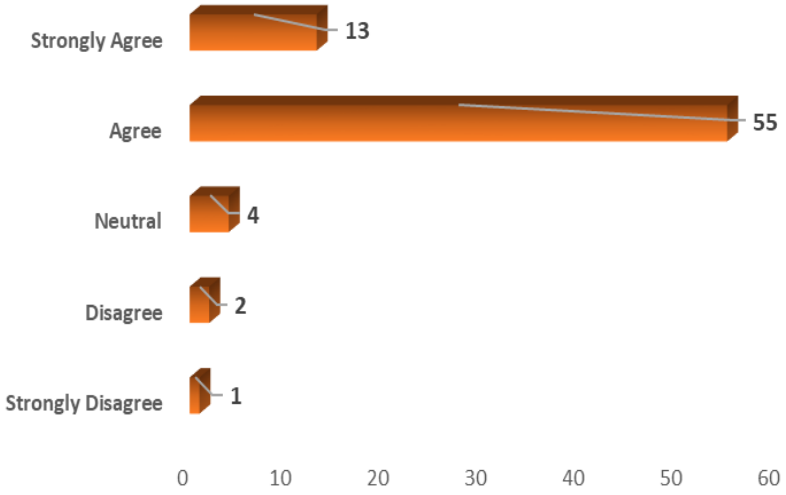

Figure 5. The result of question 5

Q6. *Cloud computing applications facilitate ease of communication and sharing of educational resources.*

In general, university administration strives to provide technical support to facilitate communication through network means. Additionally, they aim to furnish advanced technological resources and equipment through cloud computing applications to accomplish educational tasks. The response from faculty members was highly positive, with a small percentage of students denying receiving assistance. This may be attributed to the permissions and access rights of students and researchers in utilizing technological resources and equipment, as depicted in Figure 6.

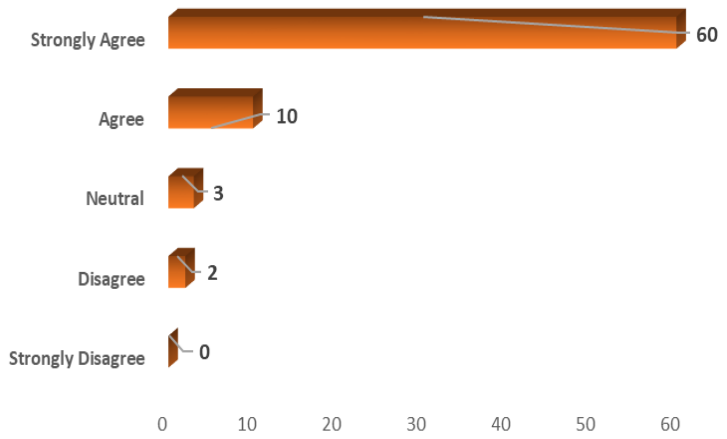

Figure 6. The result of question 6

Q7. *Cloud computing applications enable faculty members to bring together students from different categories or backgrounds*. The percentage of those who agreed that cloud computing applications allow the integration of students from different categories was high, with a low percentage of those who disagreed. This is explained by the availability of the feature to bring together students from various categories by faculty members using cloud computing applications at the university, as shown in Figure 7.

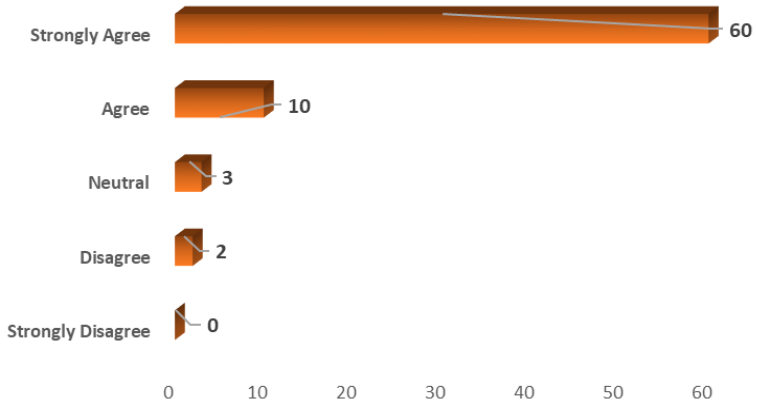

Figure 7. The result of question 7

Q8. *Cloud computing applications contribute to the development of technical skills among students*. A small percentage of students among the respondents denied the contribution of cloud computing applications to the development of their technical skills. This can be attributed to their lack of awareness of the nature of technical skills. On the other hand, the majority agreed, indicating their sufficient awareness of technical skills and how they can be developed through cloud computing applications, as depicted in Figure 8.

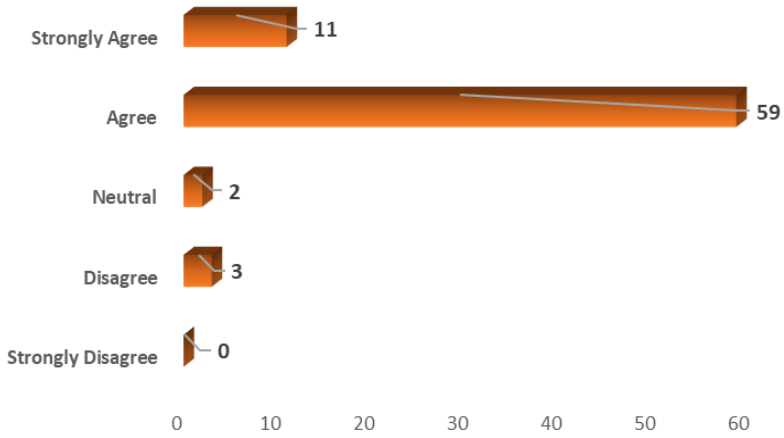

Figure 8. The result of question 8

Q9. *Cloud computing applications provide diverse assessment tools for students through feedback mechanisms*. Most responses to this question were affirmative, with a small percentage of denials. As mentioned earlier, the reason for some students' denial was believed to be due to their lack of awareness of the nature of the technical skills necessary to use the assessment tools provided by cloud computing applications, as illustrated in Figure 9.

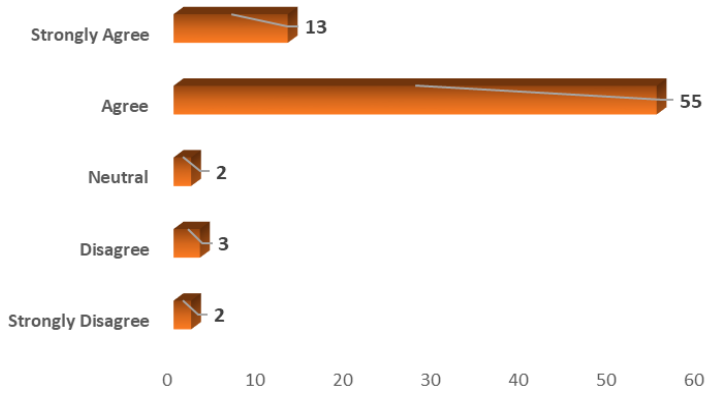

Figure 9. The result of question 9

Q10. *Cloud computing applications provide vast electronic storage spaces for file preservation*. The approval rate for this question was very high, with a lower percentage of disagreement due to their limited experience in using electronic storage tools provided by cloud computing applications, as shown in Figure (10).

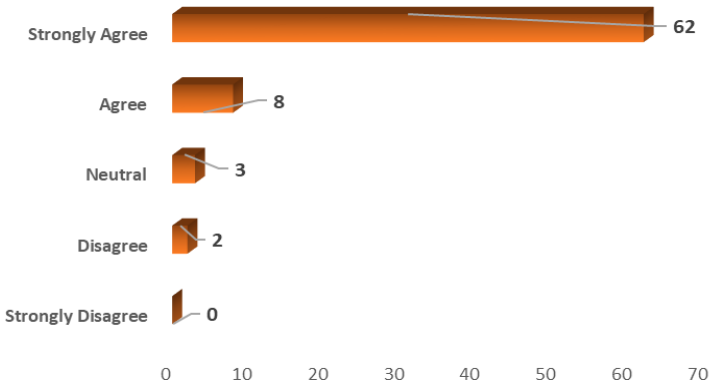

Figure 10. The result of question 10

3.2. Second dimension statements (Degree of utilization and deployment of cloud computing applications in e-learning):

Q11. *I use university email services in education as a primary means of communication and file sharing*. The approval rate among respondents was very high, with a small percentage disagreeing due to their recent enrollment in the university, as depicted in Figure 11.

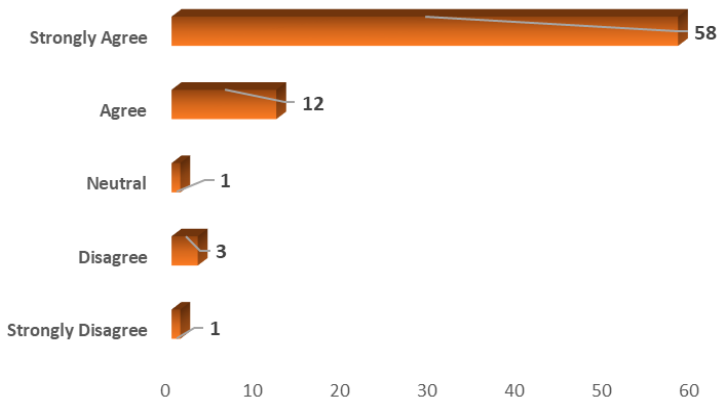

Figure 11. The result of question 11

Q12. *I use cloud computing applications such as Google Calendar to organize schedules and set reminders for important events during my studies*. The largest percentage of responses was "neutral", with a smaller percentage denying it. This was due to changes in the criteria for monitoring the use of cloud computing applications by faculty members and students for technologies such as organizing schedules and setting reminders for important events during studies, as shown in Figure 12.

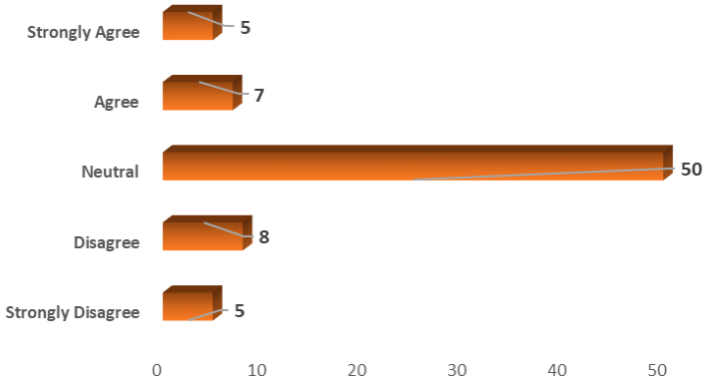

Figure 12. The result of question 12

Q13. *I use cloud storage services such as Google Drive and OneDrive in education to store and share files*. Most responses were in "agreement", while the remaining percentage provided "neutral" answers. This was most probably attributed to a lack of awareness among some respondents regarding the use of cloud storage services available at the university, as illustrated in Figure 13.

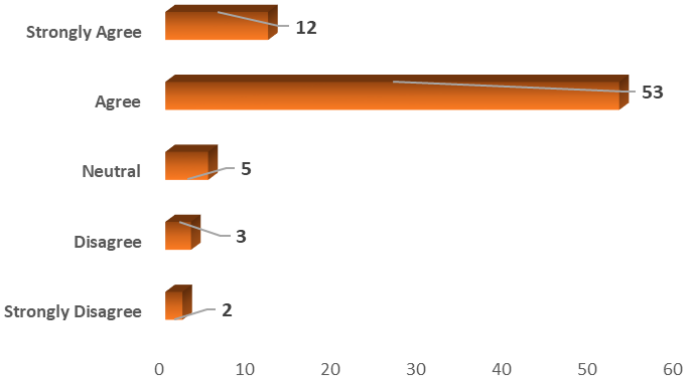

Figure 13. The result of question 13

Q14. *I use cloud computing applications to create interactive files, such as Google Docs, and electronic spreadsheets like Google Sheets, and share them for collaborative work*. The highest percentage of responses was in "strong agreement", confirming the use of cloud computing applications to create interactive files. There was a lower percentage indicating a lack of experience with these applications, as shown in Figure 14.

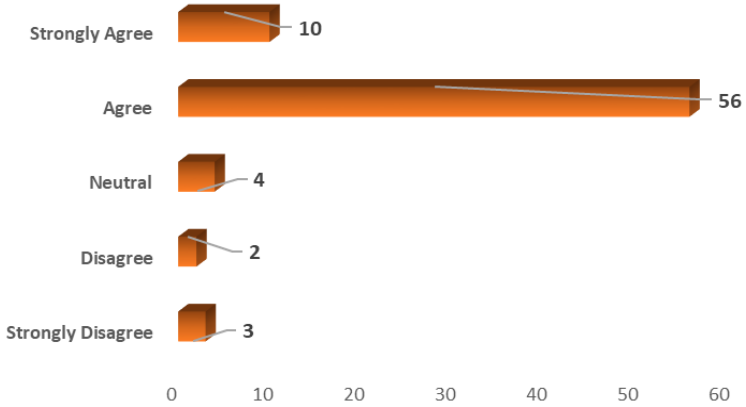

Figure 14. The result of question 14

Q15. *I use cloud computing applications for virtual classrooms available in Learning Management Systems such as Blackboard, Zoom, and Microsoft Teams in education*. The majority of responses strongly agreed with this, confirming a high degree of usage of cloud computing applications for virtual classrooms at King Faisal University, as depicted in Figure 15.

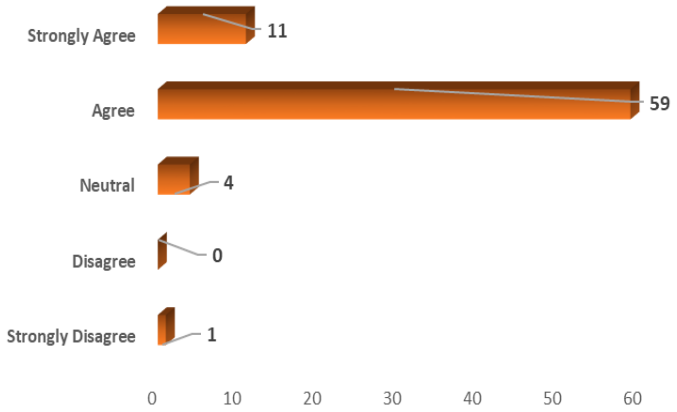

Figure 15. The result of question 15

Q16. *I use cloud computing applications for conducting interactive electronic exams and assessments*. The majority of responses denied the existence of mechanisms for conducting interactive electronic exams. However, a small percentage indicated the presence of such mechanisms. This suggested the need for clear technological mechanisms for assessment through electronic cloud applications and educating faculty members and students on how to use them, as shown in Figure 16.

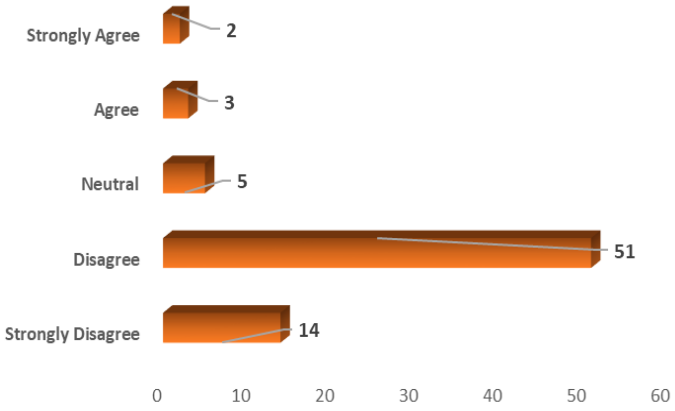

Figure 16. The result of question 16

Q17. *I use cloud computing applications to create and submit assignments and tasks*. The largest percentage of responses denied using cloud computing applications to create and submit assignments and tasks. This confirms what was mentioned in the interpretation of the results of the previous question, as shown in Figure 17.

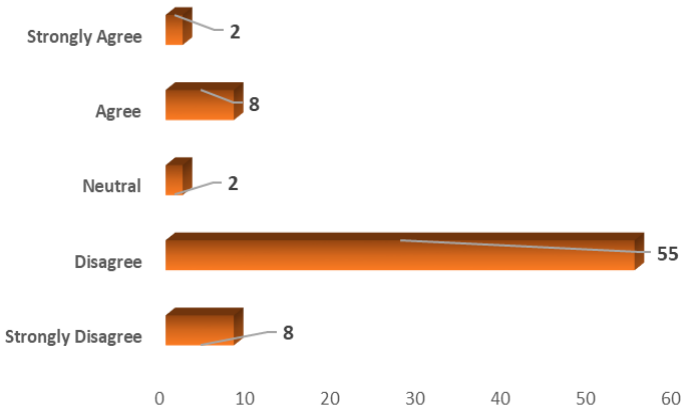

Figure 17. The result of question 17

Q18. *I use cloud computing applications such as Google Meet, Zoom, and Microsoft Teams for conducting advisory meetings*. The majority of responses agreed with this, confirming a high degree of usage of cloud computing applications for conducting advisory meetings at King Faisal University, as depicted in Figure 18.

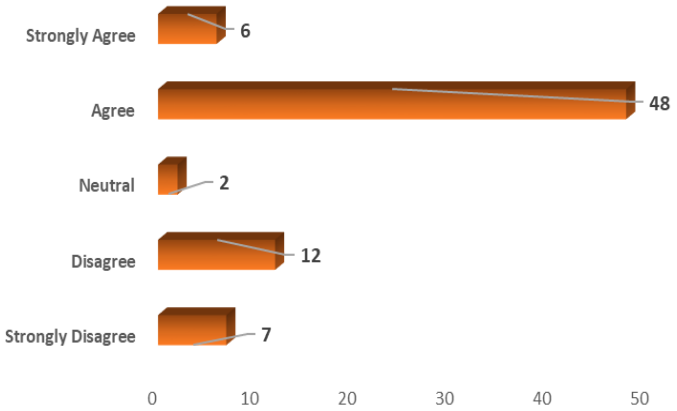

Figure 18. The result of question 18

Q19. *I use the YouTube application to create or upload educational videos and share them*. The highest percentage of responses was in moderate agreement, with a lower percentage denying it. Again, this was most probably due to a lack of awareness of the skills required to use the YouTube application for creating or uploading educational videos and sharing them, among faculty members and students, as shown in Figure 19.

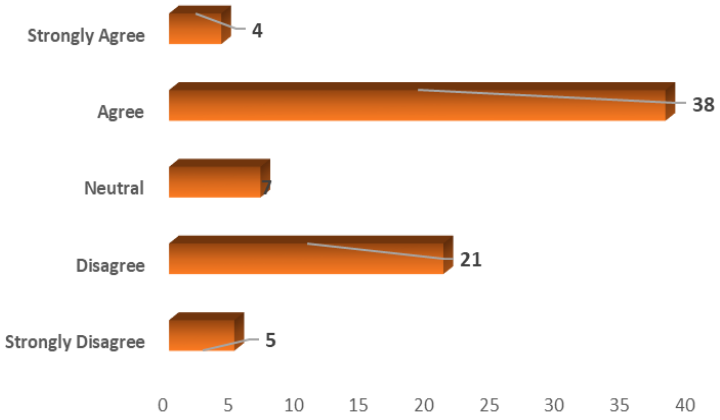

Figure 19. The result of question 19

Q20. *I use internet browsers such as Google Chrome and Microsoft Edge to access and utilize academic content in education*. The highest percentage in the responses was "strongly agree", confirming a high degree of usage of internet browsers such as Google Chrome and Microsoft Edge to access and utilize academic content in education, as shown in Figure 20.

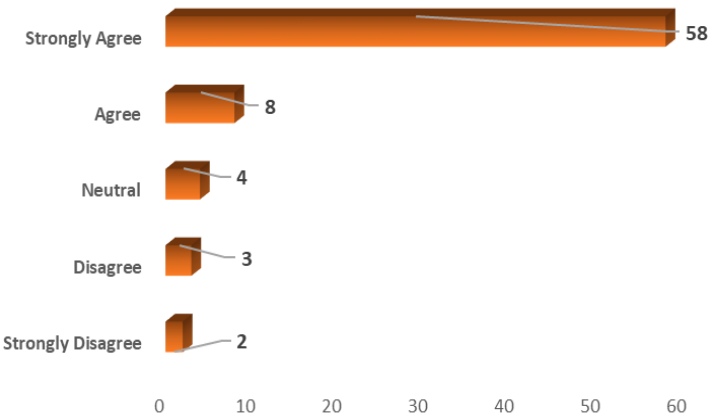

Figure 20. The result of question 20

Q21. *I use the free version of cloud computing applications' services for educational purposes*. The largest percentage of responses was "neutral", with a smaller percentage denying it. This was most probably due to a lack of awareness of the available free services of cloud computing applications for education provided by the university, as shown in Figure 21.

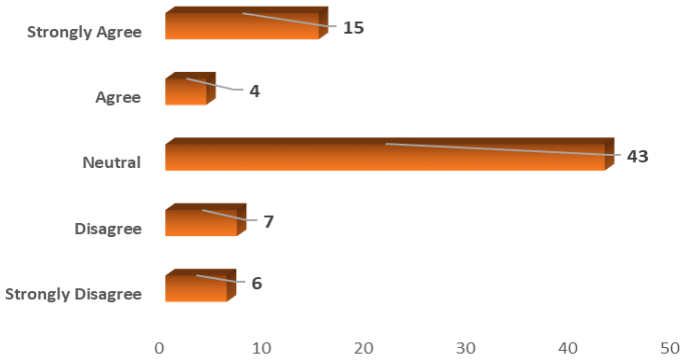

Figure 21. The result of question 21

Q22. *I use the paid version of cloud computing applications' services available at the university for educational purposes*. The largest percentage of responses denied using the paid version of cloud computing applications' services available at the university for educational purposes. Again this was due to a lack of awareness of the available paid services provided by the university, as shown in Figure 22.

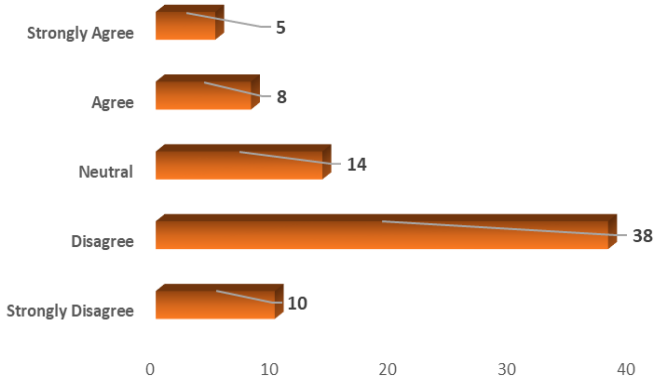

Figure 22. The result of question 22

3.3. Third dimension statements (obstacles to the use of cloud computing applications in e-learning):

Q23. *The lack of sufficient awareness and good understanding of cloud computing concepts and the services they offer represents a barrier to the utilization and deployment of its applications for faculty members and students at the university*. Most of the responses concurring with this were high, which might be attributed to the lack of training to enhance awareness of the concepts and skills related to cloud computing and the services provided by the university in this regard, as indicated in Figure 23.

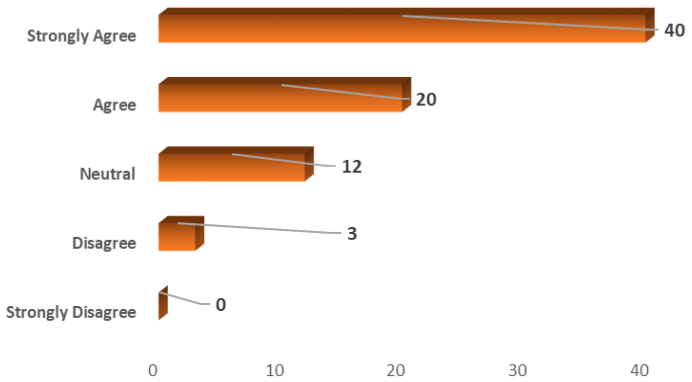

Figure 23. The result of question 23

Q24. *The student's lack of response and interaction with cloud computing applications due to their limited awareness poses a challenge to their effective utilization*. The highest percentage of affirmative responses was very high, while a lower percentage denied it. This can be attributed to a lack of awareness of the diverse interaction methods facilitated by cloud computing applications in education, as illustrated in Figure 24.

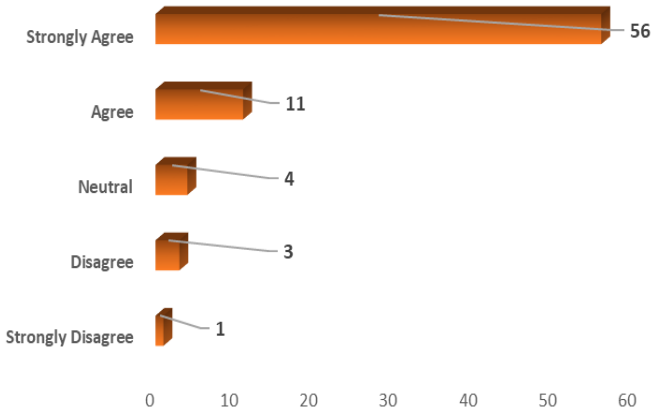

Figure 24. The result of question 24

Q25. *Slow internet speed and inadequate technical support services often hinder my progress*. The highest percentage of responses negated the existence of weakness in internet speed and technical support services, while a small percentage indicated some shortcomings. This emphasized the need for a continued enhancement of technical support services effectiveness at the university in general, as shown in Figure 25.

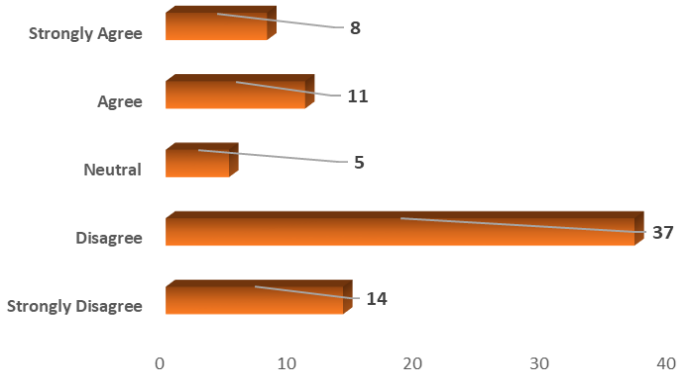

Figure 25. The result of question 25

Q26. *The deficiency in technical and support services constitutes a significant obstacle to the deployment of cloud computing applications at the university*. The largest percentage of responses was "neutral", with a smaller percentage affirming the statement. This can be attributed to changes in monitoring and control standards for technical and support services related to the deployment of cloud computing applications at the university, as illustrated in Figure 26.

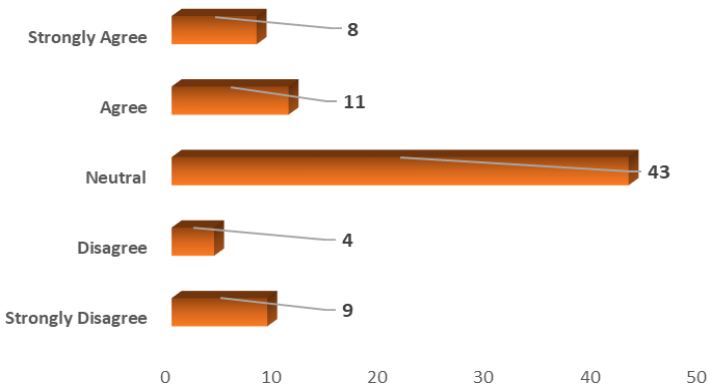

Figure 26. The result of question 26

Q27. *The lack of technical skills in using cloud computing among some faculty members results in diminished electronic interaction*. The percentage of responses affirming this statement was high, indicating the existence of deficiencies in technical skills for using cloud computing among some faculty members, as shown in Figure 27.

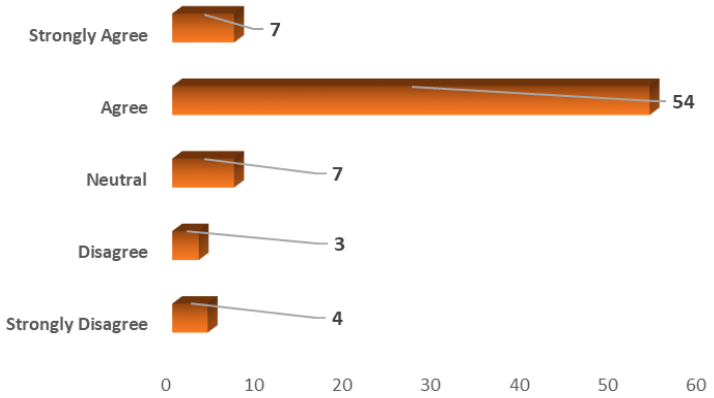

Figure 27. The result of question 27

Q28. *The lack of technical skills in using cloud computing among some students results in diminished electronic interaction*. The percentage of responses affirming this statement was very high, indicating the existence of deficiencies in technical skills for using cloud computing among some students, as shown in Figure 28.

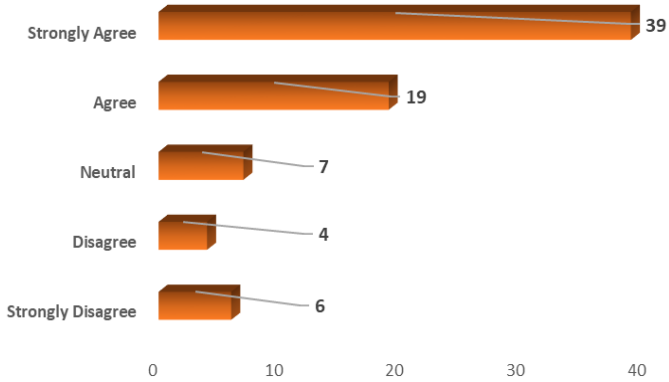

Figure 28. The result of question 28

Q29. *The fear of the risks associated with the lack of data protection assurance on cloud computing applications diminishes the activation of their usage*. Most responses strongly agreed with this, indicating a high level of technological fear or apprehension related to potential security breaches and data piracy resulting from the use of cloud computing applications. This emphasizes the necessity of increasing awareness about the tools and measures provided by the university to safeguard data, as well as staying updated on cyber security protocols within the university, as shown in Figure 29.

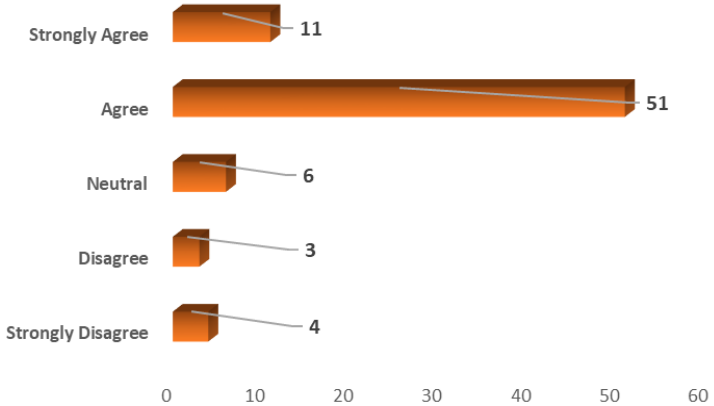

Figure 29. The result of question 29

Q30. *The absence of guarantees to protect the intellectual property rights of educational materials is the reason behind the limited utilization of cloud computing applications by faculty members and students*. The majority of responses strongly agreed with this, confirming the findings of the previous question, as shown in Figure 30.

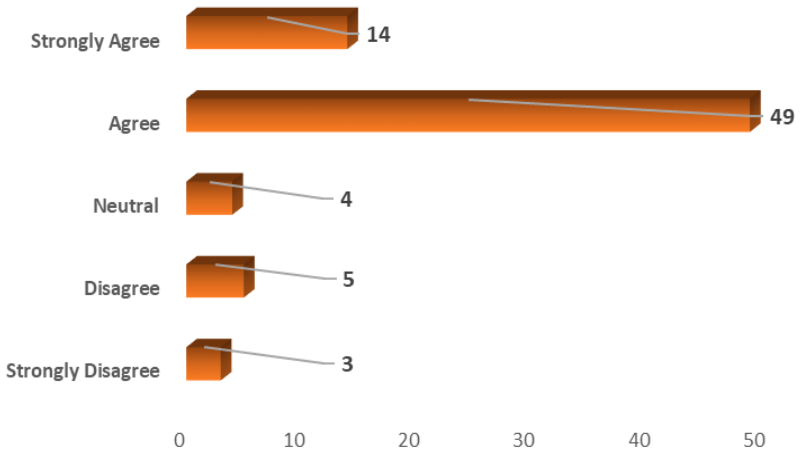

Figure 30. The result of question 30

The response level of faculty members and students to all statements related to the dimension of the advantages of cloud computing in education was high. The overall average for the high response was 3.858, with a standard deviation of 0.96. This indicates a tendency towards high agreement, with a consistent response from the sample individuals. This suggests a positive perception of using cloud computing applications at King Faisal University. The statements related to the benefits of cloud computing applications in education, such as flexibility in extending learning, and contributing to its sustainability anytime and anywhere. Easy communication and resource sharing, increased storage spaces, and reduced cost of acquiring media), received very high agreement ratings from the sample individuals, with computed averages of 4.019, 4.13, 4.18, and a standard deviation of 0.8.

In this context, the results of this study regarding the first dimension align with the findings of a study by Alhawi et al concerning the advantages of cloud computing in extending and sustaining education [5]. Moreover, the results are consistent with studies conducted by Mohamed, Soka, and Miroslav [1] [17], and Duha Khalid et al. [22], all of which concluded that the use of cloud computing in education contributes to the development of technical skills for students. It also assists both faculty members and students in accessing, storing, and retrieving files. Additionally, the results were in agreement with the findings of Dillon et al regarding the benefits of cloud computing applications in increasing student interaction and participation in the educational setting [11]. The analysis of statements related to the second dimension revealed that the usage level of cloud computing applications by the research sample, including faculty members and students at the university, is moderate. This was reflected in the overall average of this dimension, which was 3.441, with a standard deviation of 1.05. However, a variation in the usage level was observed based on the nature of the applications. Notably, a very high usage level was observed for email applications and internet browsers, with computed averages of 4.22 and 4.56, and standard deviations of 0.8 and 1.4, respectively. The results related to the use of cloud storage applications in education by the sample individuals indicated a high agreement with an average of 3.64 and a standard deviation of 1.2. Conversely, a weak level of usage was recorded for cloud applications related to creating calendars, conducting interactive tests, and using applications that require payment for service with university funding. The computed averages for these applications were 2.56 and 2.33, with standard deviations of 1.3. The results for the remaining statements showed moderate agreement levels, with standard deviations ranging between 0.8 and 1.2. This reflects the varying opinions of the sample individuals regarding the degree of usage of these applications in education.

The study results regarding the second dimension align with the findings of Amr Elkoshiry concerning the necessity of improving education through the use and implementation of educational technologies in the

educational setting in general [15]. However, the current study differs from the results obtained in the study by Handoyo & Anas regarding students' inclination toward using modern educational technologies, including applications provided by cloud computing [16].

Despite the similarities in the characteristics of the sample individuals between the current study and the study of Handoyo and Anas [16], a moderate level of usage was observed among the present study participants at King Faisal University. Nevertheless, the study results support the need to integrate modern educational technologies in the educational setting and enhance their effectiveness, particularly in increasing the usage of cloud computing applications in education. This is in line with promoting sustainable development competencies in education. The analysis of statements related to the third dimension indicated that faculty members and students at King Faisal University, as part of the research sample, agreed on the existence of challenges, difficulties, or obstacles that limit the use of cloud computing applications in education. The computed averages for the statements in the third dimension ranged between 2.13 and 4.31. The majority of opinions ranged between high agreement and very high agreement, resulting in an overall average for this dimension of 3.631 with a standard deviation of 1.087. The present results confirmed the agreement on the presence of a lack of awareness about available technical support methods at the university and a lack of responsiveness and interaction by many students with the e-learning tools and resources available at the university through cloud computing. The lack of awareness about the capabilities of cloud computing had the most significant impact on the emergence of obstacles, with computed averages for awareness-related statements reaching 4.31 and 4.42, and standard deviations of 1.4 and 0.8, respectively.

Results related to the lack of necessary skills for cloud computing due to fear of associated risks showed a moderate level of agreement, with computed averages of 4.00 and 3.97 and standard deviations of 0.8 and 1.4, respectively. Overall, the computed total average of the participants' opinions regarding the obstacles to using cloud computing applications in e-learning was 3.631, with a standard deviation of 1.087, indicating the presence of challenges and obstacles facing faculty members and students in the use of cloud computing applications in e-learning. The study results regarding the third dimension align with the findings of studies conducted by Hassan et al. [2] and Ben Youssef et al. [21] regarding the lack of necessary skills among faculty members and students for using cloud computing applications. Additionally, the results are in line with the conclusions of Amr Elkoshiry [15] regarding the necessity to enhance the effectiveness of employing educational technologies in the educational setting, to address obstacles of using cloud computing applications in e-learning. The results also correspond to the findings of the above studies in terms of the fear associated with using cloud computing in education due to concerns about data protection from hacking.

4. Conclusion

The results of this study confirmed the existence of certain needs that require development to enhance the utilization of cloud computing applications in universities. Additionally, the study identified obstacles that need solutions, with a key focus on developing approaches for dealing with available educational technology tools. It emphasized the necessity of formulating a strategy that outlines essential technical services and capabilities for faculty members and students. This, in turn, might contribute to promoting sustainable development in education. The survey was developed based on a series of questions that played a significant role in uncovering current weaknesses and highlighting needs. Furthermore, the study provided suggestions and mechanisms that could contribute to improving the performance of the e-learning and information technology deanships in governmental universities, facilitating the effective deployment of cloud computing applications to enhance sustainable development in education.

This study presented several recommendations aimed at enhancing sustainable development in education through modern technologies. This could be achieved by improving the utilization and integration of cloud computing applications in e-learning, as one of the modern technologies employed through educational techniques. This follows a comprehensive study on the extent of using these applications to activate e-learning.

The most significant findings of this study point to a challenge hindering the effective deployment of available applications, which could be categorized into four areas: technical infrastructure, data security and protection, service costs, and adequate training and qualification for users. The recommendations particularly emphasize the training and qualification domain, which can contribute to empowering universities to address challenges and obstacles, thereby promoting sustainable development in education.

Based on the results of the present study, the following recommendations could be presented:

- Conduct training courses for faculty members and students to enhance their skills in using and deploying available cloud computing applications.
- Organize workshops, whether in-person or remote, bringing together the technical team, faculty members, and students, to raise awareness about the importance of transitioning to cloud solutions in e-learning to promote sustainable development in education.
- Strengthen the technical infrastructure to provide sufficient support for the use of cloud computing applications.
- Enhance security and privacy by implementing effective security measures and promoting awareness regarding data protection to address security concerns.
- Provide free-of-charge services for university staff by offering multiple subscription options.
- Evaluate and monitor the performance of technical support departments professionally and transparently, identify weaknesses, address them, provide feedback to these departments, and follow up on improvements.
- Conduct periodic assessments for all faculties regarding the level and extent of using available cloud computing applications in the university. Based on this, address weaknesses and enhance strengths in this regard.

Declaration of competing interest

The author declares that have no known financial or non-financial competing interests in any material discussed in this paper.

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References

[1] Mustafa, Othman Arafat Hassan, "Cloud Computing and E-Learning Technologies", Journal of Research in Qualitative Education Fields, No. 22, pp. 156-164, 2019.

[2] Hassan, Nafisa Abdul, Abdel Rahman, Abdel Rahman Gaber, Ali Hassan Ahmed, Ahmed, Shadli Sadeq Mohamed, and Waei, Saleh Fadel Sayed Hamad, "Cloud Computing and its Relationship with E-Learning and its Utilization in Sudanese Universities: A Case Study of Aldaien University", Rehan Journal for Scientific Publishing, No. 32, pp. 196-216, 2023.

[3] Al-Omari, Manal A'id., "The Degree of Utilizing Educational Technologies in Educational Science from the Perspective of Male and Female Teachers in Public Schools and its Relationship to Some Variables", Educational Journal, No. 96, pp. 729-750, 2022.

[4] Ibrahim, Sayed Ali Ismail, Damyan, Georgiette Damyan George, Al-Qasabi, Rashed Sabri Mahmoud, and Marjan, Rania Qadri Ahmed, "Utilizing E-Learning in Industrial Secondary Schools to Achieve Educational Quality", College of Education Journal, No. 20, pp. 305-347, 2016.

[5] Al-Hawi, Yazid, and Arouri, Youssef, "Are University Students Aware of the Use of Cloud Computing Technology as Supplementary Learning?", Jarash for Research and Studies, No. 2, pp. 5427-5446, 2022.

[6] Briscoe G., Marinos A., “Community Cloud Computing”, First International Conference, CloudCom 2009, Beijing, China, December 1-4, 2009.

[7] Sultan, Basim Akhtar, "Perceptions of Graduate Students Regarding the Use of Cloud Computing Applications During the COVID-19 Pandemic", Ramah Journal for Research and Studies, No. 71, pp. 113-154, 2022.

[8] Report on the results of the digital content platforms market survey, Communications, Space & Technology Commission, KSA, 2022.

[9] Saudi Data & Al Authority, “Dictionary of Data and Artificial Intelligence”, p 50, 2022.

[10] Mekawie, N., & Yehia, K., “Challenges of Deploying Cloud Computing in health”, International Conference on Project Management / HCist - International Conference on Health and Social Care Information Systems and Technologies 2020. 181, pp. 1049-1054, 2021.

[11] Dillon, T., Wu, C., & Chang, E., “Cloud Computing: Issues and Challenges”, 24th IEEE International Conference on Advanced Information Networking and Applications, pp. 27-33. IEEE, 2010.

[12] A. Khalid, M.Shahbaz, "Cloud Computing Technology: Services And Opportunities", Pakistan Journal of Science, Vol. 65 No. 3 September, 2013.

[13] Alkurri, N. M., Gadouh, K. A., Khalil, E. M, “A Proposed Model for Risks Management Measurement in Cloud Computing Environment: Software as a Service”, V22, pp. 118-130, 2023.

[14] Khalifa, Zeinab Mohamed Hassan, "Cloud Computing Services and Their Role in the Educational Process", Journal of Studies in Higher Education, No. 31, pp. 507-522, 2015.

[15] El-Koshiry, Amr Mohamed, "Improving the performance of higher education: Quality Standards of Educational Technologies and Their Applications", Arab Association for Educational Technologies, Educational Technology Journal, Studies and Research, Volume 52, Issue 3, Pages 1-22, 2022.

[16] Handoyo, S., & Anas, S., “Accounting Education Challenges in the New Millennium Era: Impact of Advanced of Technology and Dynamic Business Environment”, Journal of Accounting Auditing and Business, 2(1), 25-33, 2019.

[17] Musicarova, S., & Beblawi, M., "Adopting an Incremental Approach for Comprehensive Education Reform", Arab Cities Organization, No. 187, pp. 82-83, 2021.

[18] Grandisoli, E. and Jacobi, P., R., “Post-COVID-19 Education and Local Transformation”, Instituto de Estudos Avancdos da Universidade de Sao Paulo, Sao Paulo. AEDS 10,2 272, 2020.

[19] Fernando Parra, Aimee Jacobs, Laura L., Trevino, “Shippy Express: Augmenting accounting education with Google Sheets”, Journal of Accounting Education 56, https://doi.org/10.1016/j.jaccedu.2021.100740, 2021.

[20] Mohamed, Wael Hussein, "Utilizing Cloud Computing Services to Enhance Higher Education Accounting in Egypt", Ain Shams University, Faculty of Commerce, Department of Accounting and Auditing, No. 4, pp. 580-638, 2018.

[21] Ben Youssef, Khalf Allah, and Qouidar, Maash, "The Need for Cloud Computing to Develop E-Learning in Higher Education Institutions: Between Theory and Application", Perspectives Journal of Sciences, University of Ziane Achour Djelfa, No. 3, pp. 957-969, 2022.

[22] Duha Khalid Abdul-Rahman Al-Malah, Ibtisam A Aljazaery, Haider Th Salim Alrikabi and Hussain Ali Mutar, “Cloud Computing and its Impact on Online Education”, doi:10.1088/1757-899X/1094/1/012024, 2021.