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PAPER

Exploring the Impact of Peer Mentoring on Computer-Supported Collaborative Learning among Undergraduate Students

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ABSTRACT

Research indicates that peer mentoring supports students learning and emotional stability. However, its usability and impact in Computer-Supported collaborative (CSCL) learning activities that enhance students' learning in and outside the classroom require contextual exploration. Hence, this study examined the usability and impacts of peer mentoring in CSCL among undergraduate students using a mixed-methods research approach. Data collection was conducted by administering a questionnaire with both qualitative and quantitative elements. Data analyses started with thematic coding of the nuanced texts collected through open-ended questions, and structural equation modelling (SEM) was used to analyze the quantitative data. Findings show that students have a different understanding of collaborative learning, but a common acknowledgment is that peer mentoring is beneficial in CSCL. Importantly, student views are impacted by gender, college affiliations, and CSCL experience. Drawing on the findings, we conclude that peer mentoring's acceptability in CSCL is feasible and can affect students' learning positively. However, it should be planned effectively and deployed based on contextual data showing students' preference for CSCL and their peculiar need for peer mentoring.

KEYWORDS

peer mentoring, CSCL, undergraduate students, SEM

1 INTRODUCTION

Computer-Supported Collaborative Learning (CSCL) is an approach to education that employs technology and computing software to support group work and student communication. It has become an increasingly popular pedagogical approach in higher education because of its potential to enhance collaboration among students within the traditional classroom and virtual learning environments. Using social computing software and platforms, including discussion forums, blogs, learning

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management systems (LMS), videos, and wikis, CSCL strengthens students' learning and emotional well-being by providing alternative means for engaging and sharing ideas [1]–[3]. Consequently, educators keep experimenting and deploying different CSCL tools to foster student interaction and engagement, empowering them to learn from peers while building knowledge [2], [4]. Besides, the digital learning requirements due to the COVID-19 pandemic have made online learning a common practice in academia[2], [5], with the need to ensure the active participation of students.

In line with the constructivist learning philosophy, CSCL is conceived on the premise that students can co-construct knowledge through collaborative learning strategies adequately and intentionally supported by technological platforms and resources. Collaborative learning refers to learners building knowledge together [6]. As reported, collaborative learning is a social enterprise crucial to the context within which successful learning occurs in a community established for mutual benefits [7]–[9]. In addition, researchers acknowledged the fundamental role of social interaction in developing the learning process [10], [11]. As argued, all social interactions, including those involving social conflicts, may lead to cognitive development and reorganization [of ideas and thoughts] [12]. So, the construction of shared understanding and active interaction among participants are the key objectives of collaborative learning [13].

While the approach has many pedagogical benefits, it can also be challenging in higher education. For instance, CSCL is often a more complex learning environment than traditional face-to-face learning, requiring students to be able to use technology to communicate and collaborate, often with limited technical support [14], which can be difficult for those not adept at using digital tools [14], [15]. Also, some may lack the competence and skills to collaborate with others. In such situations, students could feel isolated, disconnected, or demotivated in a CSCL [16]. Students' access to digital tools and being technology savvy may also not translate into effective and intentional use of CSCL tools and platforms for academic purposes [17], [18].

In enhancing CSCL and other technology-enhanced pedagogies, Khan et al. [19] argue that educators need to consider a continuum in the use of educational technology from teacher-centered to student-centered. Through this process, students can take ownership of the learning process while supported by more experienced peers and instructors [20]. Engaging in a deep process of cooperating by students can assist in reducing the challenges affecting CSCSL [15]. A well-documented interventionist approach to support students' cooperative and engaging learning is peer learning mechanisms [21], such as peer mentoring.

As conventionally described, peer mentoring is a formal process in which a more experienced student assists novice peers in transitioning into and navigating the institution, leading to their personal and academic growth [22], [23]. In contrast, it is seen as a non-hierarchical collaboration among peers, allowing them to learn from one another. This collaborative learning conception is guided by constructivist pedagogy enabling students to share ideas, co-construct knowledge [24], and assist each other academically, psychologically, and socially [25]. Not surprisingly, studies report that peer mentoring increases students' confidence, transferrable skills (emotional, communication, and leadership), and academic attainment in collaborative learning endeavors [26]–[28]. It also can improve student engagement and enhance retention with positive impacts on motivation and study behaviors [29] through good relationships, and networks developed [27].

Despite the well-documented benefits of peer mentoring in students' collaborative learning endeavors, it may not be easily implemented or meritoriously facilitated because of different contextual conditions [25], including those peculiar CSCL

platforms. Perhaps, this explains why educators are expected to continuously explore pedagogical frameworks and activities for strengthening teaching and learning in online education settings [2], [4], [30], [31]. Given our desire to enhance our students' engagement in CSCL using peer mentoring, we agree that educators must carefully design CSCL, and its supporting strategies should be implemented considering students' specific needs, preferences, feedback, and assessments that explicitly align with them [2]. Thus, we conducted this study to explore students' understanding of CSCL, its usage, and how peer mentoring can strengthen their learning in CSCL in a semi-public university in the United Arab Emirates (UAE). The following research questions guided our data collection and analysis process:

1. How do students describe CSCL in this research context?
2. To what extent do students use CSCLs in their learning process?
3. What are the possible impacts of peer mentoring and its usability on students' CSCL engagements?

2 METHODS

2.1 Research design

In this study, we employed survey research, allowing researchers to collect information from respondents through their responses to goal-oriented questions [32] and explore constructs considering appropriate variables [33]. Using a self-designed survey questionnaire, we collected quantitative and qualitative data. We opted for this mixed-methods approach to reach out to many respondents and gain insights into their subjective thoughts [2], [34], including their perceived goals and constraints informed by their different backgrounds [13]. In addition to questions addressing the research objectives, we also asked questions to collect demographic information from the respondents to determine their impact on peer mentoring and CSCL.

2.2 Participants and data collection

In recruiting participants, we sent an electronic questionnaire to the students at a semi-private university in the United Arab Emirates (UAE) after getting institutional approval for the funded project (VCRGS/R.447/2020). We asked volunteers to participate in the study by taking approximately 15–20 minutes to complete the online questionnaire. After two months with two reminders, 227 consented to participate and completed the questionnaires.

Over half of the respondents were female (64%), while the rest, 36%, were male. Students from all thirteen colleges at the university responded. However, we categorized the colleges into three main groups for a reasonably robust analysis of the data collected. The groups are Arts and Social Sciences (Arts, Humanities and Social Sciences, Business, Communication, Fine Arts and Design, Law, and Sharia and Islamic Studies), Medical (Dental Medicine, Heath Sciences, Medicine and Pharmacy), and Sciences (Computing and Informatics, Engineering, and Sciences). The respondents' age groups varied over the following four categories 17–20, 21–24, 25–28, and 29 years and above.

2.3 Data analysis and modelling procedures

We analyzed the data collected using both quantitative and qualitative strategies, as explained below.

Generating themes. Using an inductive thematic approach, we analyzed the qualitative data collected through open-ended questions. As argued, it is a strategy to identify, organize, describe, and report themes emerging from qualitative data collected [35]. In ensuring the trustworthiness of the thematic analysis, we followed the six steps extensively discussed in [36]. We started by familiarizing ourselves by reading the transcripts severally for immersion, critical reflections, and intellectual engagements about key ideas emanating from the data. We then generated the initial codes through document reviews and peer debriefing, after which we carefully reviewed the emerging themes using detailed notes and diagraming to visualize the codes' connections. In the fifth stage, we defined the themes by checking consistencies employing researchers' triangulations and peer debriefing regarding the themes. Lastly, we presented the results with themes and supporting codes, giving detailed and contextual descriptions of the findings.

Descriptive statistics and modelling using SEM. We used the mean and standard deviation to analyze parts of the quantitative data collected, after which we further analyzed the data using the Structural Equation Model (SEM). We considered SEM an appropriate technique because the unobserved (latent) variables, constructed from a combination of different variables, are better and feasibly investigated through SEM [37]. In particular, SEM-based on the partial least squares (PLS) technique was used to model and assess the impact of variables on each other. The SEM-PLS is a widely used SEM method based on variance and is usually employed to identify relations between the variables and latent variables. As Bang et al. [38], the characteristics of the PLS method are effective, do not take the distributions of the provided data (normality), and mitigate the problem of small sample bias.

The SEM technique requires mapping the expected impact of each variable on the other, as shown in the sample SEM diagram (Figure 1). The binary and numeric values (e.g., the scale of agreement) can be directly used and input into latent variables (circles in Figure 1). On the other hand, if a latent variable has more than one input, the inputs are called manifests (squares in Figure 1). Moreover, as categorical variables are considered in this study (e.g., male or female and college affiliation group), PLS shall be divided depending on the subdivided categories, as shown in Figure 2, which is also known as Multigroup analysis (MGA). MGA (also called between-group analysis) tests predefined data groups to investigate the existence of significant differences across group-specific parameter estimates [39].

As shown in Figure 2, in the general model, including both genders, factor 2 has 0.4 impact on factor 3. At the same time, an in-depth analysis of each group shows that the male category has a higher impact (0.6) than the female category. This emphasizes that the impact is due to a group of whole participants. This may cause alteration in the decision-making process of a specific field. The details of computations and examples of SEM can be found in Hair et al. [38]. MGA SmartPLS 4.0 software was utilized in performing the SEM-PLA, which is specialized software for SEM analysis [40].

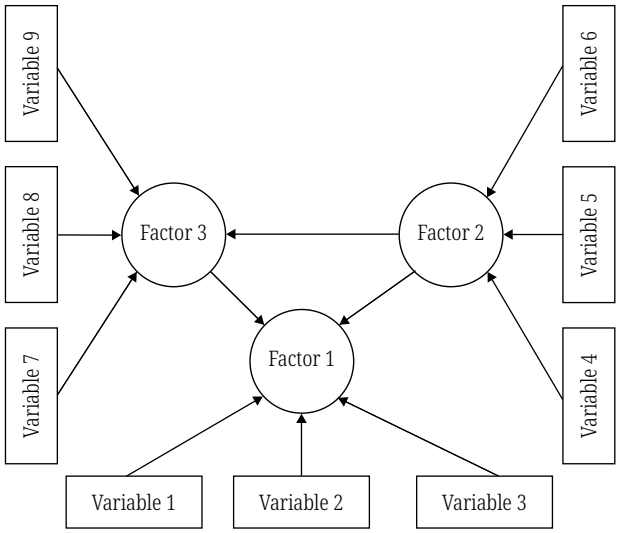


Fig. 1. Sample of structural equation model diagram for 9 manifests and 3 latent variables

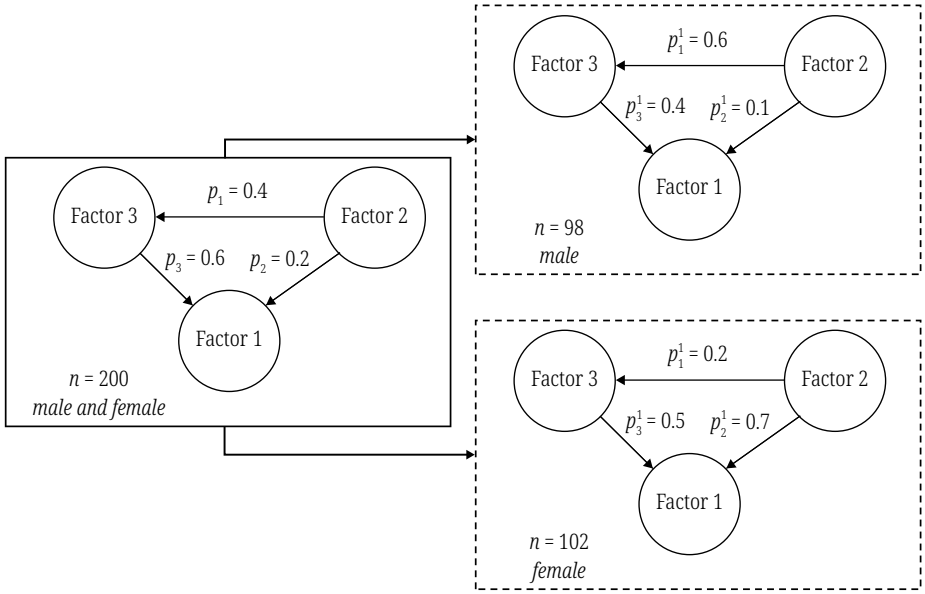


Fig. 2. Example of grouped analysis structural equation model

3 RESULTS

3.1 How do students describe CSCL in the research context?

To answer this research question, we asked students to explain CSCL based on their understanding. Below, we present the four themes emerging from the data analyzed in Table 1:

Table 1. Students' understanding and description of CSCL

Themes	Narrative Vignettes
Learning collaboratively using technological and online platforms	Computer Supported Collaborative Learning refers to learning situations mediated by technologies where small groups of students are interacting. Computer-Supported collaborative learning is the work of peers as a group using online resources. Since many people are working online due to the global pandemic, different ways of working are needed to complete certain tasks, these ways include, online discussion, breakout rooms, online meetings in zoom and MS Teams, social media, etc. I think it is beneficial as it increases our understandings of the subjects we are studying for but sometimes there are certain people who don't bother to cooperate which is a major problem in most group work or projects and the reason why so many students prefer to do work individually.
Fosters easy connections among students	It helps facilitate learning and understanding by giving students the opportunity to interact and discuss with others more easily. Computer-Supported collaborative learning is very useful nowadays, especially since students cannot work together face-to-face because of the pandemic. Actually it's much easier for people around the world they can study and stay with their families and for people who work but for me I can't really get the point studying with computer.
Offers flexible learning opportunities	It's better in terms of providing flexible time and place for meeting. It is really beneficial and helpful since it does not need the student to be in a specific geographic location to be educated. Students can basically join the session from any part of the world. It has more benefits and one of them that we can meet any time especially if there was emergency and also we save time, we don't need any transportation and to be honest we start to talk it makes us to be bold.
Not so beneficial or appreciated as a learning approach	It doesn't have a similar feeling like face-to-face learning and it is more likely for the students to not be collaborating through a computer. I don't really like it, the lack of face to face contact and understanding makes it worse than working alone. Computer-Supported collaborative learning is not for everyone. Some may feel as though they perform better in-person and others virtually.

From the data presented, it is clear that students' understanding and description of what CSCL entails differ. Predominantly, their descriptions suggest that CSCL is beneficial as it facilitates collaboration, easy interaction, and flexible learning opportunities. On the other hand, some students may not value the approach as they may prefer face-to-face engagements. These varied conceptions and understandings could impact their attitudes to learning when CSCL is deployed. In the next section, we wanted to know the extent to which students have experience using CSCL.

3.2 To what extent do students use CSCL in their learning process?

To answer the second research question, we investigated the number of CSCL tools the students were exposed to and used (out of 10). The average results of CSCL tools used for each age group and college orientation are summarized in Figure 3, and the error bars represent the standard deviation from the average. The results

showed that, regardless of age, the social sciences had almost the highest amount of CSCL used compared to other college students. This sentiment sounds reasonable as one of the main aspects of social sciences is social interaction, which encourages the students to use as much CSCL as possible. Moreover, the medical-oriented programs had the lowest number of CSCLs used regardless of age. This may be attributed to many clinical-related activities and less time for engagement using CSCL.

On the other hand, increasing the age groups from 17–20 to 29 and above had a noticeable impact on the number of CSCLs used by university students. The results have shown that increasing the age has a proportional increment in CSCL tools used, which could indicate the intentional use of CSCL as students mature and understand the institutional terrain.

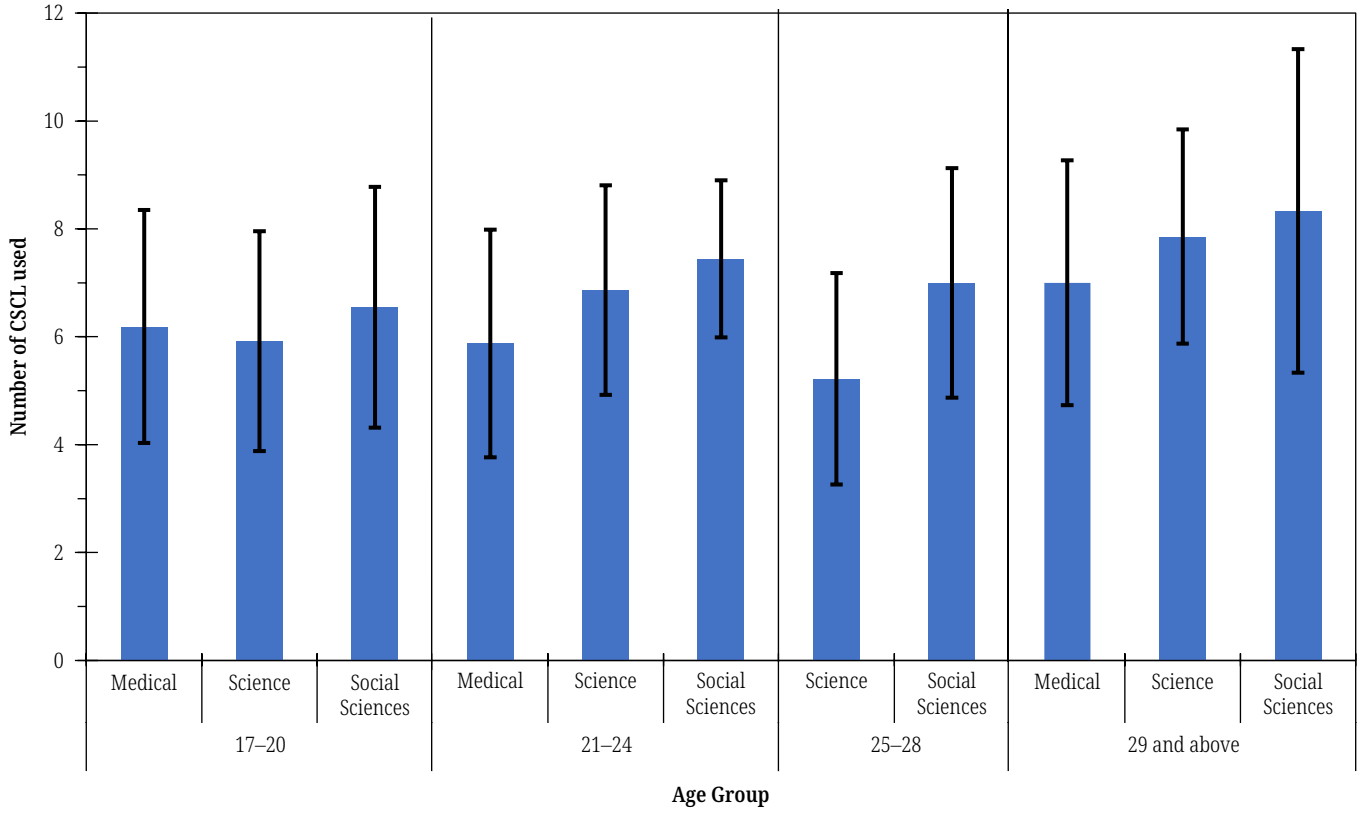


Fig. 3. Average number of CSCL used for each students' age groups and college orientation

The results of the average rating of peer mentoring usability in CSCL are summarized in Figure 4, and the error bars represent the standard deviation from the average. As shown, almost all colleges and age groups had an average value above 3 out of 4 in the rating of peer mentoring usability in CSCL, which indicates positive feedback on the prospect of peer mentoring acceptability in CSCL. Overall, a slight proportional trend in peer mentoring usability can be observed as the age group increases. Interestingly, social sciences had the highest score for peer mentoring usability in the age group of 25–28, while the reverse is the case for the age group of 29 and above to be the lowest scoring.

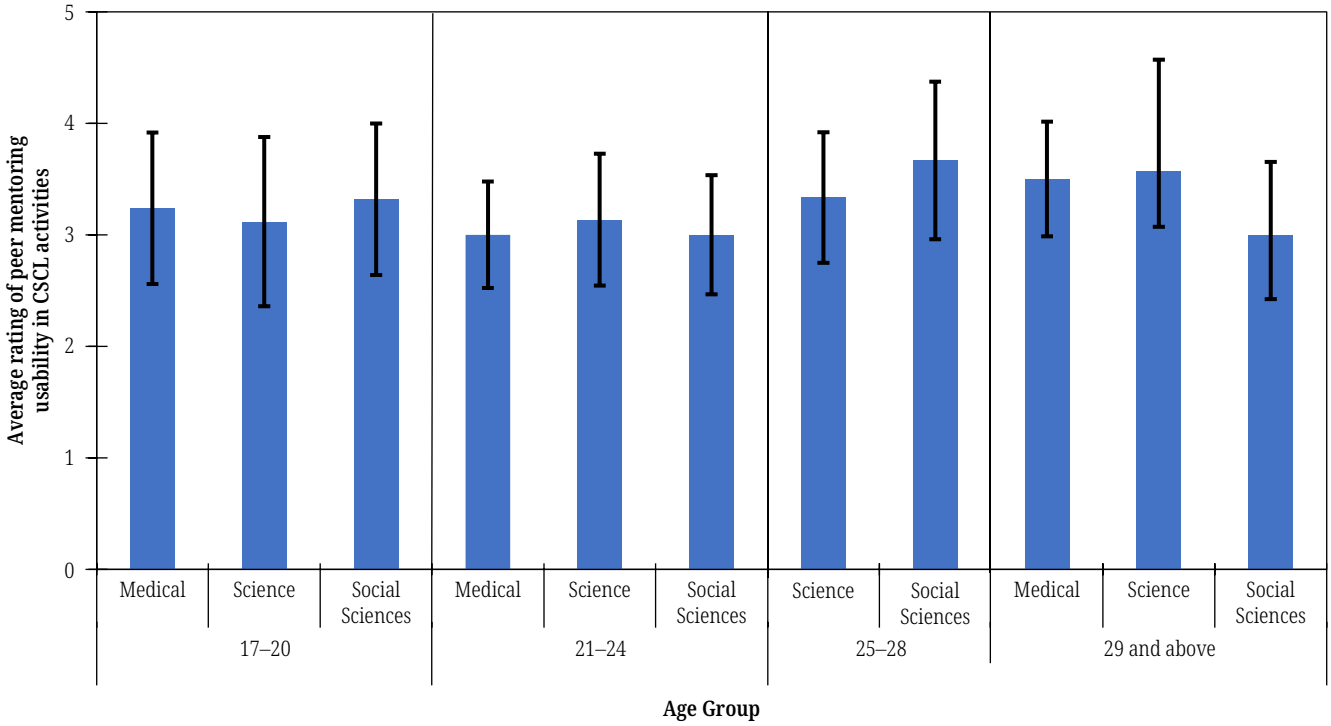


Fig. 4. Average rating of peer mentoring usability in CSCL activities for each students' age groups and college orientation

The data presented here explicitly indicate that students have considerable CSCL experience in this context. Besides, they see peer mentoring as a tool for supporting their learning in CSCL platforms. In the next section, we examine the impact of peer mentoring and its usability using SEM.

3.3 What are the impact of peer mentoring and its usability in students' CSCL engagements?

In answering the question, we developed the framework shown in Figure 5 using SEM and tested it against different variable sets. The year of study was linked to all other latent variables due to the impact of age groups discussed previously. In addition, the number of CSCL activities used, the rating of how helpful CSCL is, the collaboration rating, and negative experience using CSCL activities were all summed in one latent variable, namely, experience using CSCL. Then, the benefit of social media on peer mentoring was directly connected to the benefits of peer mentoring with all other latent variables. Finally, the importance of peer mentoring activities for students' learning and emotional stability, along with the usability of peer mentoring to enhance students' CSCL activities, were linked with the benefit of peer mentoring latent variable.

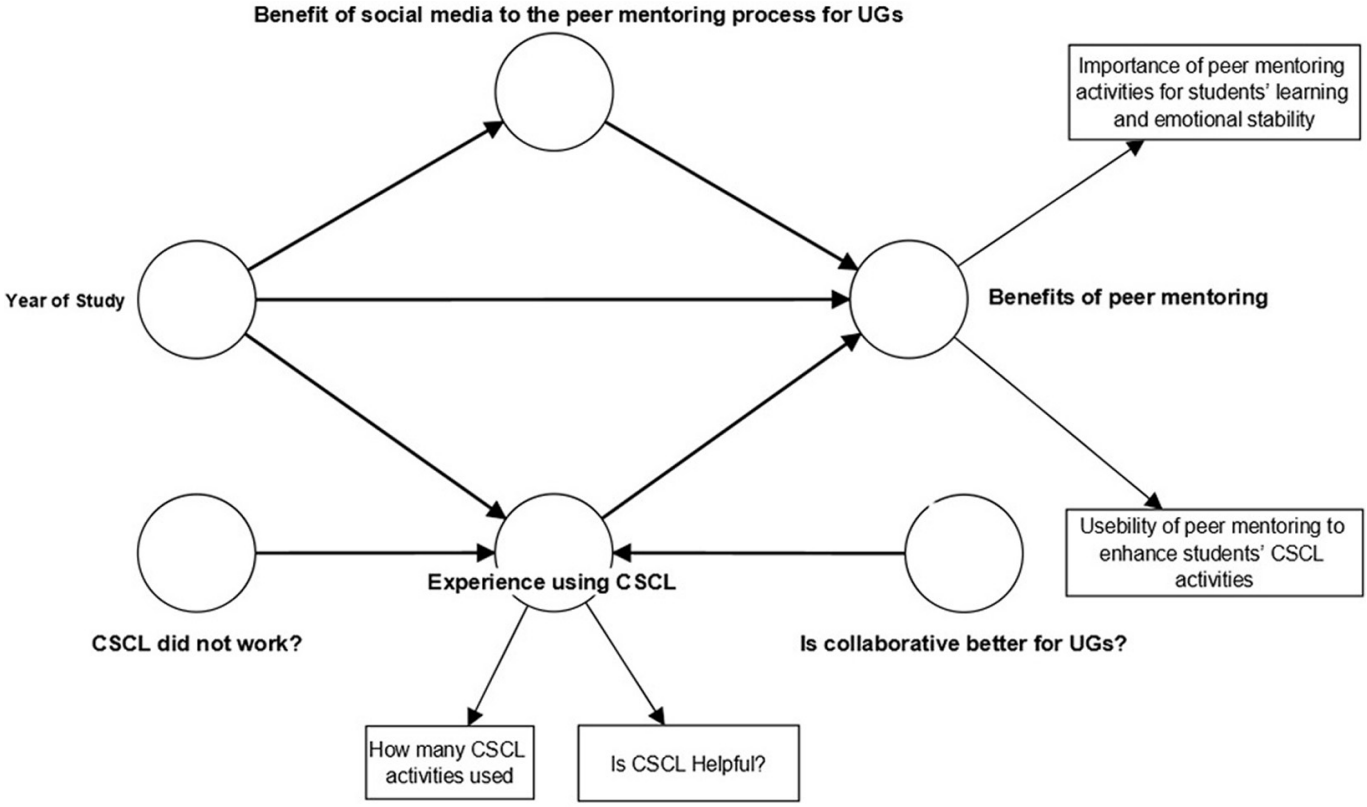
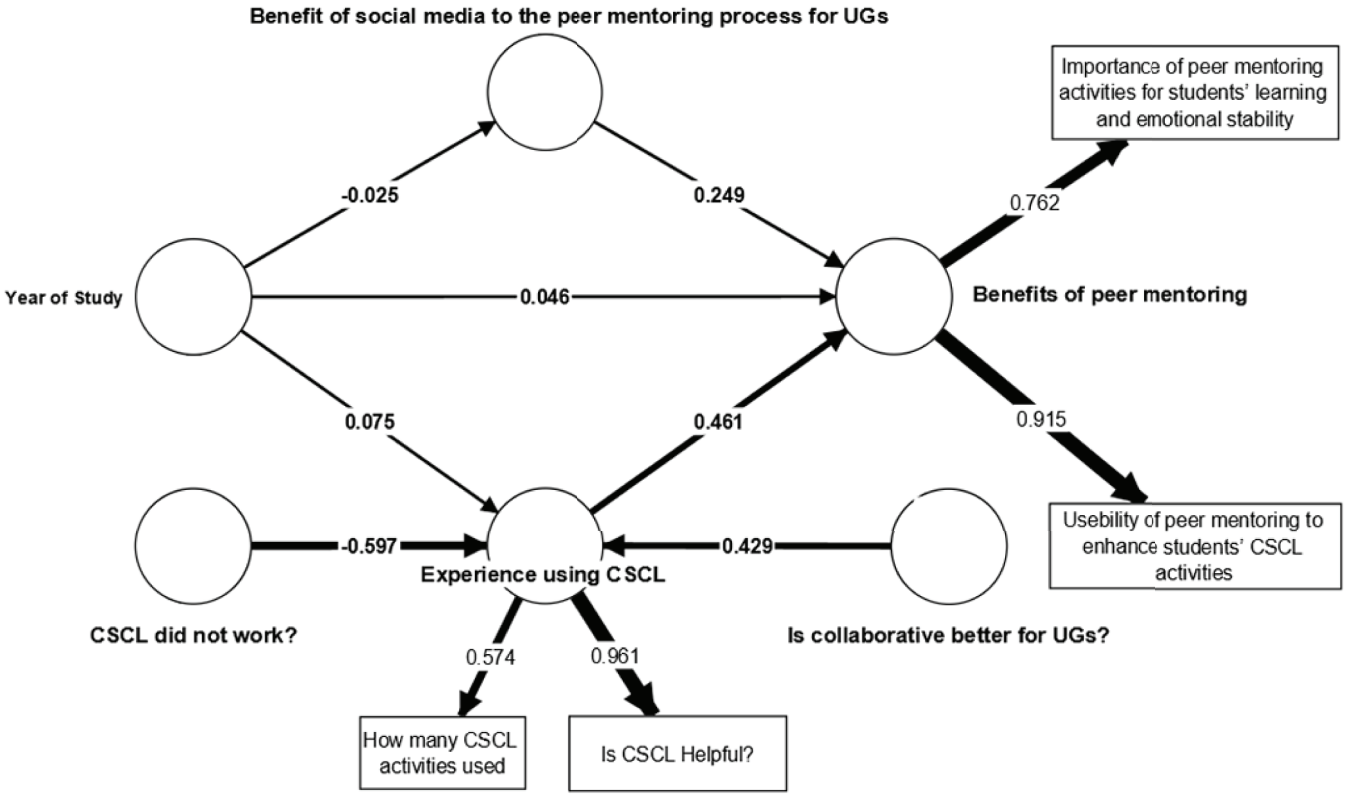


Fig. 5. Proposed peer mentoring-CSCL structural equation modelling

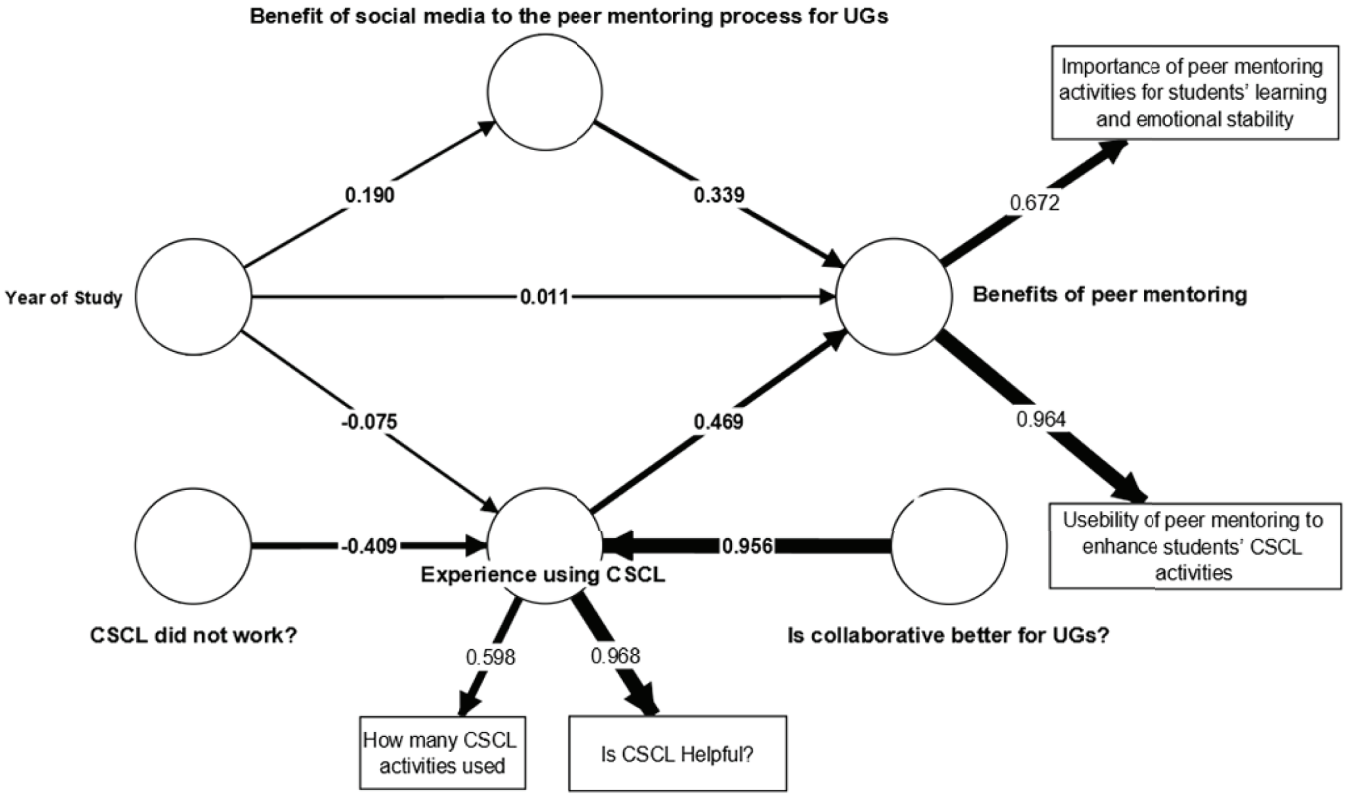
Impact of gender. As discussed previously in the methodology section, MAG was conducted to assess the impact s of each categorical variable individually. The total impacts of all variables on each other were investigated separately for the female group (Figure 6a) and the male group (Figure 6b). The results are shown schematically and numerically; the thicker the connected line indicates a higher impact regardless of sign direction.

In terms of both: the importance of peer mentoring activities for students learning (0.762 for females and 0.672 for males) and the usability of peer mentoring to enhance CSCL (0.915 for females and 0.964 for males) have significant impact on the benefits of peer mentoring regardless of the gender. In addition, both genders' models had the highest and most considerable variable for how helpful CSCL is (0.961 for females and 0.968 for males)—indicating that the latent variable experience using CSCL and the benefit of peer mentoring was highly affected by the benefits provided from CSCL.

On the other hand, a clear difference was observed in the collaboration opinions impact, as the female group had an impact of 0.429 while the male group had more than twice the effect (0.956). This finding indicates that the males tend to find that collaboration has a high impact on CSCL and the learning process of computer-aided collaboration, which was not the case in the female group.



(a)



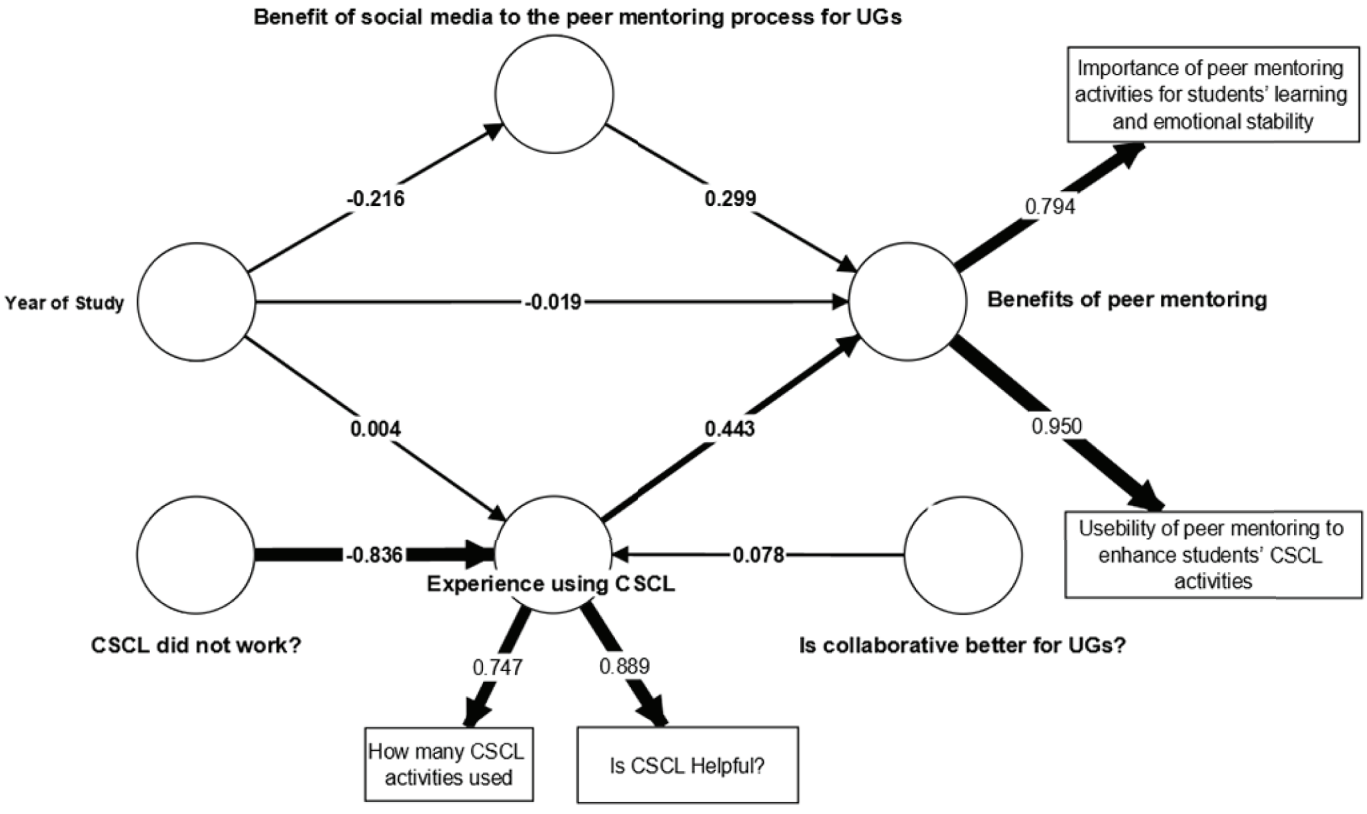
(b)

Fig. 6. SEM-PLS MAG total impact results for a) female, and b) male groups

Impact of college orientation. Similar to the gender impact, the college orientation effects were also analysed. The SEM-PLS MAG results are summarized in Figure 7a, b, and c for medical, science, and social sciences. As revealed, all college orientation models had almost the highest significant variable for how helpful CSCL is, similar to gender effects. Furthermore, the benefit of the peer mentoring part (importance of peer mentoring activities for students learning and usability of peer mentoring to enhance CSCL) significantly impacted all college orientation models.

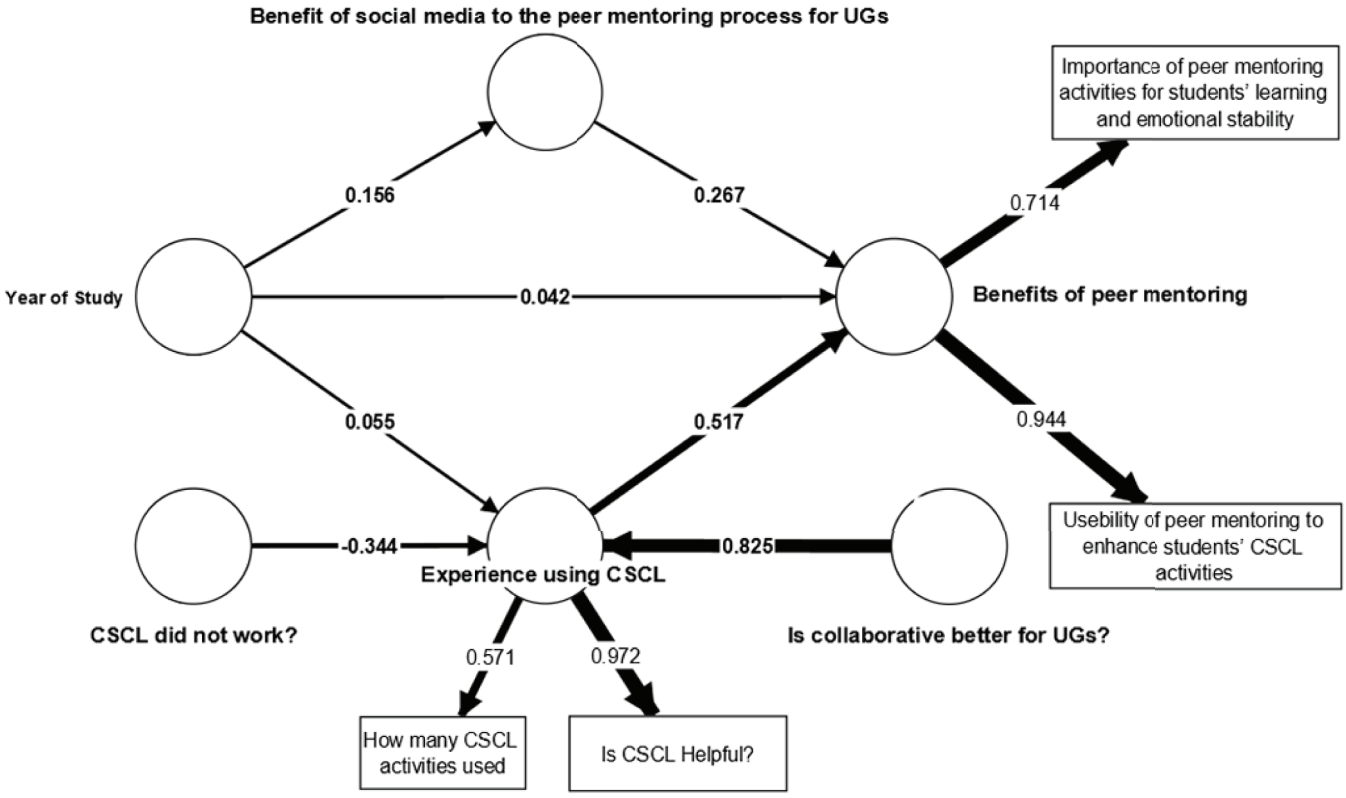
The experience of CSCL had an almost similar impact on gender models. However, the experience in CSCL for college orientation had slightly different total effects. Experience in CSCL had values of 0.443, 0.517, and 0.391 for medical, science, and social sciences, respectively, indicating that science-oriented colleges are affected in CSCL due to peer mentoring, while social sciences-oriented colleges had the lowest total effects. This result suggests that social sciences-oriented colleges have experience in CSCL and may appear to be less dependent on peer mentoring than other orientations.

On the other hand, medical and social science-oriented colleges had a significantly high impact on the model from non-working CSCL activities. This finding highly affects the experience of CSCL, which indicates the need to deploy CSCL tools capable of helping students to learn to enhance their CSCL experience, especially the medical and social science-oriented colleges.



(a)

Fig. 7. *(Continued)*



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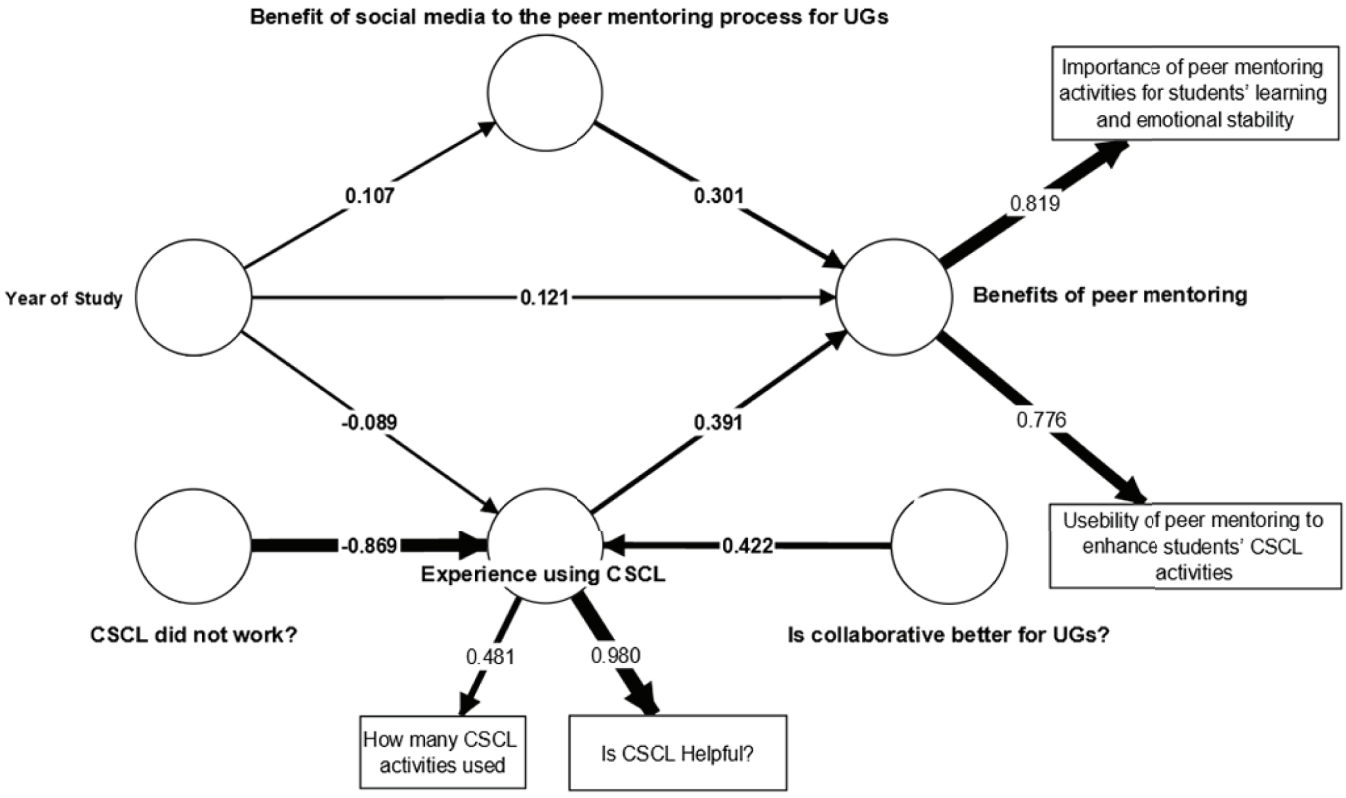

(c)

Fig. 7. SEM-PLS MAG total impact results for a) medical, b) science. and c) social sciences

4 DISCUSSION

This study sets out to explore the role and impact of peer mentoring in CSCL among undergraduate students. In completing the research, we started by getting students to describe what CSCL means in the qualitative phase. Overall, students' descriptions of CSCL reflect the constructivist pedagogical philosophy, recognizing the critical role of collaboration and knowledge-sharing endeavours in learning processes [2], [7]. Students see CSCL as encompassing collaborative learning, easy connection, and flexible opportunities to engage in learning conversations on technology-enabled platforms. Thus, the findings suggest that students are most likely to interface and engage in collaborative endeavours to co-develop knowledge [6] in a mutually beneficial community of learners [7]–[9]. Consequently, the findings underline educators' need to continually explore and deploy CSCL tools and platforms to enhance students' learning. Not surprisingly, previous studies highlight the essential roles of social interaction in effective teaching and learning processes [10], [11]. However, educators must acknowledge that CSCL may not be appreciated or treasured as a learning approach by some students [2], [7]. As the data revealed, some students may prefer face-to-face learning instead of CSCL platforms. Indeed, educators stand the chance of facilitating students' learning effectively when their thoughts and feedback are considered while planning and implementing pedagogical approaches, including CSCL.

Regarding the extent to which students use CSCL in the study, students in the three groups indicate a reasonable use of the approach, irrespective of age. However, those in the social sciences field profoundly used CSCL, while those in the medical disciplines had the lowest rate, regardless of age. This revelation may be informed by the fact that social science fields involve more social engagement and interaction than medical fields, where students spend a considerable time learning in medical facilities and laboratories. As social interaction fosters learning processes [10], [11], the finding highlights the need for educators to create strategies for stimulating learning conversations among students. The approaches include giving students the impression and assurance that learning spaces are safe to engage physically and online [2]. Not surprisingly, students acknowledge the relevance of peer mentoring in CSCL and rate its usage highly across academic and age groups. However, students in the social sciences field have the highest usability rating of peer mentoring in CSCL in ages 25 to 28, while they have the lowest in ages 29 and above. This finding reinforces the previous indicator about social science students' high social engagement rate while suggesting that older students use CSCL less than their younger counterparts. It also underlines the need for the personalization of CSCL to maximize its benefits [2] among students of different age groups and college orientations. Therefore, it is essential to consider these findings for the planning and deployment of peer mentoring in CSCL among undergraduate students.

As the literature indicates that testing causal relationships is central to SEM [37], we tested the relationships of different variables with peer mentoring in the CSCL context using SEM. The findings show that the usability of peer mentoring for enhancing CSCL significantly affects the benefits of peer mentoring irrespective of gender. On the other hand, the importance of peer mentoring activities for students' learning and emotional stability greatly impacted the benefits of peer mentoring for females compared to their male counterparts. So, peer mentoring acceptability among students in this context is likely to be high as it has the potential to enhance their learning, emotional stability, and CSCL activities. The two gender-focused

models indicate that students overwhelmingly considered CSCL helpful. However, the data demonstrate that more female students did not consider CSCL valuable compared to male students, even though they are in the minority. The findings align with previous studies rating peer mentoring as a viable tool to enhance students' learning [22] and highlighting the relevance of CSCL [2].

Nonetheless, educators need to bear in mind that some devices may not be considered beneficial to some students, and efforts should be directed at knowing why that is the case to determine the appropriate way to enhance CSCL usage. The two results also show that the merits of CSCL significantly impacted students' experience of CSCL usage and the benefits of peer mentoring. So, students need to find CSCL beneficial for rewarding learning experiences and engaging in peer mentoring through platforms. In terms of collaboration, students' opinions differ as the male group has twice the impact of CSCL in collaborative endeavours than their female counterparts. This result indicates that male students find collaboration through CSCL more impactful.

As for college orientation, the results indicate a high impact on peer mentoring and the benefits of CSCL across the colleges. This reinforces the previous finding, suggesting the possibility of a keenness for peer mentoring in CSCL. However, students' experience of CSCL as related to peer mentoring differs based on their college affiliation. As the results indicate, the medical field has the highest, followed by the science and social sciences, indicating that the social sciences field may be less dependent on peer mentoring in CSCL as they may have more exposure than their counterparts. Thus, peer mentoring planners and educators must acknowledge these preferences when planning and deploying peer mentoring in CSCL. On the other hand, respondents from the medical and social science-oriented colleges had a significantly high impact on the model from non-working CSCL activities. This revelation indicates the need to select the most preferred CSCL for students based on their college affiliation, as some tools may be considered less effective. Interestingly, students from the sciences field have a low value for CSCL not working in the model. Previous studies have indicated the need for educators to consider tools in line with students' preferences to assist in achieving course learning outcomes [2].

5 CONCLUSIONS

In this study, we developed and tested a framework for planning and deploying peer mentoring in CSCL using the SEM approach. Based on the data analysed and discussed, the feasibility and usability of peer mentoring in CSCL are not in doubt. Thus, this study opens up new directions for CSCL researchers, policymakers, and stakeholders in higher education seeking contextualized information to enhance CSCL using peer mentoring by employing the SEM approach. The outcomes of this study also have implications for policy-making related to peer mentoring in CSCL. For instance, higher education institutions should encourage active use of CSCL in the teaching and learning process, with training provided or funded, while different CSCL platforms are purchased. This investment allows educators to use various CSCL tools to personalize students' learning experiences and prepare them for active engagement with colleagues in the peer mentoring process. Besides, peer mentoring in CSCL should be institutionalized by the management and adequately supported by the deanships at the college level. Doing this ensures that students' CSCL and peer mentoring needs are customized in line with college orientation, gender, and age group, enhancing students' collegial learning experiences in familiar terrains.

6 ACKNOWLEDGMENT

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