

Promoting Learners' Engagement To Maximize Learning In A Synchronous Online Workshop: A Case Study Analysis From Different Perspectives

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Abstract. As cloud computing becomes increasingly popular, the need for professionals with cyber security expertise for cloud platforms has become crucial. Continuous education initiatives are vital for ensuring that professionals stay current on the latest advances in cyber security for cloud computing. In this context, synchronous online workshops have emerged as a popular medium for delivering such educational programs, particularly given the flexibility and convenience they offer to learners. This study investigates the effectiveness of the Context Challenge Activity Feedback (CCAF) framework in promoting learners' engagement to maximize learning in a synchronous online workshop on the Fundamentals of Cyber Security for Cloud Computing. It utilizes a mixed-methods approach to analyze post-workshop survey responses, colleagues' feedback, and facilitator observations. Findings indicate that the CCAF framework successfully engages learners, fosters collaboration, and improves learning outcomes. Participants reported satisfaction and a likelihood to recommend the workshop. The study contributes insights into applying the CCAF framework in synchronous online workshops, particularly in cyber security and cloud computing education, and highlights the implications for instructional design and facilitation. Future research should explore the CCAF framework's adaptability to various learning environments, instructional modalities, and the role of technology in engagement and collaboration.

Keywords: Learners' Engagement, Active Learning, Virtual Learning, Instructional Design and Facilitation, Cyber Security Education

1 Introduction

The rapid growth of online education has increased the demand for practical instructional approaches that promote learners' engagement and active learning in online environments. Synchronous online learning environments provide a unique opportunity to foster interaction, collaboration, and active learning, enabling participants to engage in real-time discussions and activities [9, 71, 3,

5, 69, 18]. However, designing and facilitating effective online learning environments can be challenging, as it requires careful consideration of various factors, including the choice of instructional frameworks, the use of technology, and the alignment of activities with learning objectives [33, 68, 1, 8, 41, 43, 63]. In this context, the current study aims to explore the effectiveness of the Context Challenge Activity Feedback (CCAF) framework [4] in promoting learners' engagement to maximize learning in a synchronous online workshop.

The CCAF framework, based on four key components—context, challenge, activity, and feedback—provides a systematic approach to designing and facilitating learning experiences that encourage engagement, collaboration, and deep learning [4]. The framework emphasizes establishing a meaningful context, presenting learners with relevant and challenging tasks, promoting active involvement in learning activities, and providing timely and constructive feedback. In recent years, the CCAF framework has gained attention as a promising instructional approach for various learning settings, including face-to-face, blended, and online environments [67, 70, 4, 56]. However, there is limited empirical evidence on the CCAF framework's effectiveness in synchronous online workshops, especially in cyber security and cloud computing education.

This paper addresses this research gap by presenting a case study analysis of a synchronous online workshop on the Fundamentals of Cyber Security for Cloud Computing, designed and facilitated using the CCAF framework. The study employed a mixed-methods approach, combining quantitative and qualitative data from participants' responses to a post-workshop survey, feedback from colleagues observing the teaching sessions, and the facilitator's observations. Through systematic data analysis, the study aims to provide insights into using the CCAF framework to promote engagement, collaboration, and learning in the online workshop and draw implications for instructional design and facilitation in similar settings.

The remaining part of this paper is organized as follows. Section 2 provides an overview of learners' engagement in online learning environments, synchronous online workshops as a learning format, the CCAF framework, and related case studies and empirical research. Section 3 describes the research design, data collection, data analysis procedures, and triangulation. Section 4 presents the main findings of the study. Section 5 discusses the interpretation of the findings, implications for instructional design and facilitation, limitations of the study, and recommendations for future research. Section 6 summarizes the study's main contributions and highlights future research directions.

2 Literature Review

This section provides an overview of learners' engagement in online learning environments. It also discusses synchronous online workshops as a learning format and the CCAF framework. Lastly, it presents a review of works related to the current study.

2.1 Learners' Engagement in Online Learning Environments

Learners' engagement in online learning environments is a crucial aspect of the educational experience. It is strongly associated with positive learning outcomes, academic achievement, and student satisfaction [25, 6, 22, 36]. Engagement in online learning can be characterized by the degree of active participation, cognitive investment, and emotional connection that learners exhibit towards the learning process, their peers, and the instructional context [6, 21, 76, 73]. It is a multidimensional construct encompassing behavioral, cognitive, and affective dimensions.

Behavioral engagement refers to the observable actions and behaviors demonstrating learners' involvement in learning [35, 66, 34, 32]. This engagement can include attending online classes, completing assignments, participating in discussions, and interacting with peers and instructors. Behavioral engagement is an essential component of online learning, as it facilitates the development of a sense of community and encourages learners to take responsibility for their learning.

Cognitive engagement involves learners' mental effort, investment, and deep processing of the course content [11, 30, 64]. Cognitive engagement is characterized by using various learning strategies, critical thinking, problem-solving, and connecting new information with prior knowledge. In online learning environments, cognitive engagement is crucial for promoting deep and meaningful learning experiences, as it helps learners to construct new knowledge and make sense of the content.

Affective engagement relates to learners' emotional and motivational aspects, such as interest, enjoyment, and sense of belonging [26, 2, 48]. Affective engagement plays a significant role in online learning, influencing learners' attitudes, persistence, and overall satisfaction with the learning experience.

Promoting learners' engagement in online environments requires a combination of effective instructional design, the use of appropriate technology, and the development of a supportive learning community [33, 68, 1, 8, 41, 43, 63]. Several factors have been identified as key drivers of engagement in online learning, including clear and relevant learning objectives, well-structured and interactive course content, timely and constructive feedback, and opportunities for collaboration and social interaction.

Furthermore, the role of instructors is essential in fostering engagement in online learning environments [38, 49, 42]. Instructors must adopt various strategies to create an engaging and inclusive atmosphere, such as being present and accessible, providing clear guidance and expectations, facilitating active learning and discussions, and offering personalized support and feedback.

In conclusion, learners' engagement in online learning environments is critical to effective education, involving a complex interplay of behavioral, cognitive, and affective dimensions. To enhance engagement, it is essential to consider various factors, such as instructional design, technology, and the instructor's role, to create meaningful and engaging learning experiences that lead to better outcomes for learners.

2.2 Synchronous Online Workshops as A Learning Format

Synchronous online workshops are a learning format in which participants attend virtual sessions in real-time, engaging with the facilitator and other attendees through various online tools and platforms [53, 24, 59, 74, 39]. This learning format is characterized by immediate interaction, collaboration, and the opportunity for instant feedback, closely resembling the dynamics of traditional face-to-face learning environments. Synchronous online workshops offer several benefits and unique features, making them a valuable choice for many educational contexts.

One of these benefits and unique features relate to interaction and engagement. Synchronous online workshops enable participants to actively engage with the facilitator and their peers through live discussions, question-and-answer sessions, and group activities [53, 50, 51]. This real-time interaction fosters a sense of community, enhances learners' motivation, and facilitates a more in-depth understanding of the subject matter.

Another benefit of synchronous online workshops is immediate feedback. The real-time nature of synchronous online workshops allows facilitators to provide instant feedback and support to learners, promptly addressing their questions and clarifying any misconceptions [10, 50, 17]. This timely feedback contributes to more effective learning experiences, as it helps learners to comprehend the content better and adjust their learning strategies accordingly.

Collaboration and group work are among the essential benefits of synchronous online workshops. Synchronous online workshops often incorporate collaborative activities, such as breakout sessions, group projects, and case studies, encouraging learners to collaborate, share ideas, and develop problem-solving skills [55, 60, 57]. This collaborative approach supports active learning and enhances participants' communication and teamwork abilities.

Synchronous online workshops can also facilitate the delivery of a structured learning experience. Synchronous online workshops are typically designed with a clear structure and agenda, which helps learners to manage their time and expectations effectively [13, 40, 75]. The facilitator guides participants through the learning process, ensuring a coherent, well-paced experience that aligns with the learning objectives.

Moreover, synchronous online workshops offer great flexibility and accessibility. Despite being held in real-time, synchronous online workshops offer flexibility and accessibility not always found in traditional face-to-face learning settings [65, 16, 15, 23]. Participants can join the sessions from any location with an Internet connection, eliminating the need for travel and reducing associated costs.

However, synchronous online workshops also have some challenges, such as scheduling difficulties due to time zone differences [29, 44], technical issues with online platforms [53, 39, 58], and the potential for reduced engagement if the facilitator does not effectively design and manage the sessions [37, 47]. Despite these challenges, when well-executed, synchronous online workshops can provide engaging, interactive, and collaborative learning experiences that effectively support learners' understanding and skill development.

2.3 The CCAF Framework

The CCAF (Context, Challenge, Activity, and Feedback) framework is a widely recognized instructional design model that promotes learner engagement, interaction, and effective learning outcomes in various educational settings, including online learning environments [4, 62, 54]. Developed by Dr. Michael Allen, the CCAF framework [4] emphasizes the importance of four critical elements to creating meaningful and engaging learning experiences: context, challenge, activity, and feedback.

Context refers to the background or setting where the learning occurs [4]. A clear context helps learners understand the content's relevance, connects the learning to their prior knowledge and experiences, and establishes a foundation for the learning objectives. In the CCAF framework, it is crucial to present the context that resonates with the learners, so they can grasp the topic's significance and feel motivated to engage with the material.

The challenge component involves presenting learners with thought-provoking problems, questions, or scenarios that require them to think critically and apply their knowledge and skills [4]. By incorporating challenges that align with the learning objectives, the CCAF framework stimulates learners' curiosity. It encourages them to engage with the content actively, fostering a deeper understanding and better material retention.

Activities are the hands-on, interactive tasks learners undertake to address the challenges presented [4]. These activities can take various forms, such as group discussions, role-plays, case studies, simulations, or quizzes. By incorporating diverse and relevant activities, the CCAF framework supports active learning. It helps learners to develop problem-solving, collaboration, and critical thinking skills, ultimately enhancing their ability to apply the acquired knowledge in real-world situations.

The feedback component of the CCAF framework emphasizes the importance of providing timely, constructive, and actionable feedback to learners throughout the learning process [4]. Feedback can come from the facilitator, peers, or even self-assessment. It should focus on learners' strengths and areas for improvement, reinforcing correct responses and guiding them toward better understanding and performance. Effective feedback supports learners' progress, boosts their confidence, and enhances their learning experience.

The CCAF framework offers a comprehensive approach to instructional design that fosters engagement, interaction, and meaningful learning outcomes. Educators and instructional designers can create compelling learning experiences that cater to the diverse needs of learners and support their development and success by addressing the four critical components of the CCAF framework.

2.4 Related Work

An overview of the relevant case studies and empirical research related to learner engagement in online learning environments, synchronous online workshops, and

the CCAF framework highlights the significance of these components in promoting effective learning experiences. Several studies and case examples demonstrate the benefits and challenges of implementing these approaches in diverse educational contexts. For example, research in [20] shows that online learning environments can foster learner engagement and satisfaction by providing interaction, collaboration, and self-paced learning opportunities. Another study in [46] indicates that students who engaged with online learning platforms, such as discussion forums and collaborative projects, demonstrated higher levels of critical thinking, problem-solving, and academic performance.

Case studies focused on synchronous online workshops highlight the importance of real-time interaction, instructor presence, and well-designed activities in promoting learner engagement and success. For instance, a study in [15] examined synchronous online workshops' impact on student learning outcomes and found that these workshops improved participants' communication, collaboration, and content understanding. Similarly, the authors in [19] explored the effectiveness of synchronous online workshops for language learning. They concluded that real-time interactions facilitated by the workshop format contributed to enhanced language proficiency and learner motivation.

Several case studies and empirical research projects have explored the application of the CCAF framework in various educational settings, often reporting positive results. In a study in [67], the CCAF framework was employed to examine the relationships between the cognitive styles of field dependent learners with the attitudes toward e-learning, resulting in positive attitudes toward e-learning programs. Another case study in [70] examines the use of the CCAF framework to guide the design of problem-based learning activities in a college-level course, finding that the framework effectively supported student collaboration, critical thinking, and the application of knowledge.

In contrast to the works in the preceding paragraphs, the current study investigates the effectiveness of the CCAF framework in promoting learners' engagement to maximize learning in a synchronous online workshop on the Fundamentals of Cyber Security for Cloud Computing. With the growing demand for professionals with expertise in cyber security for cloud platforms, there is a need for continuous education initiatives to ensure that professionals stay current on the latest advances in cyber security for cloud computing. Thus, the current study fills the gap in the existing literature by providing empirical evidence on the effectiveness of the CCAF framework in promoting learners' engagement and active learning in synchronous online workshops.

3 Methodology

This section describes the research design, data collection, data analysis procedures, and triangulation.

3.1 Research Design

The research design for this study is a mixed-methods approach, combining both quantitative and qualitative data collection and analysis to investigate the impact of the CCAF framework on learner engagement in synchronous online workshops. This design enables a comprehensive understanding of the phenomenon by integrating the strengths of both methods and providing a more nuanced perspective on the results.

The setting of the study is a synchronous online workshop on Fundamentals of Cyber Security for Cloud Computing held March 13-14, 2023. The workshop is part of Continuous Education for 16 Candidates facilitated by an instructor with Noroff Accelerate, Oslo, Norway, and observed by three members of a collegian coaching group from the Norwegian University of Science and Technology (NTNU), Gjøvik, Norway. The teaching session of the workshop is designed to provide hands-on experience using different security tools available in the two leading cloud computing platforms (Microsoft Azure and Amazon Web Services). The candidates have varying levels of experience with online learning and come from different professional backgrounds.

3.2 Data Collection

Data collection in this mixed-methods study involves three primary sources: a post-workshop survey, observations from the collegian coaching group members who attended the sessions, and the facilitator's self-reflection.

- Survey: 12 Participants completed a post-workshop survey to gather quantitative data on their engagement, satisfaction, and perceptions of the CCAF framework. The survey includes Likert scale items, multiple-choice questions, and open-ended questions.
- Observations: 3 members of the collegian coaching group attended the workshop sessions to observe and document the participants' engagement and interaction with the CCAF framework. These observations provide qualitative data on the framework's effectiveness and impact on collaboration and learning.
- Facilitator's Self-Reflection: As the workshop facilitator, the researcher conducted a self-reflection to assess the implementation of the CCAF framework, the challenges encountered, and the overall effectiveness of the workshop in promoting learners' engagement.

3.3 Data Analysis

The collected data undergo quantitative and qualitative analysis to interpret the findings and draw conclusions.

- Quantitative Data: The quantitative survey data is analyzed using Microsoft Excel descriptive statistical analysis tool by employing percentages and frequencies of responses to validate the objectivity and significance of the questionnaire items. This analysis helps identify trends and patterns in the participants’ perceptions and engagement.
- Qualitative Data: The qualitative data, including observation notes and the facilitator’s self-reflection, is analyzed using content analysis. This process involves identifying themes, patterns, and relationships within the data to understand better the participants’ experiences and the impact of the CCAF framework on their engagement.

3.4 Triangulation

Triangulation of the data from the survey, observations, and self-reflection helps corroborate the findings and enhance the study’s validity and reliability. The mixed-methods approach allows for a more comprehensive and in-depth understanding of the impact of the CCAF framework on learners’ engagement in synchronous online workshops. Thus, this study provides a robust examination of the effectiveness of the CCAF framework in promoting learners’ engagement to maximize learning in synchronous online workshops by employing a mixed-methods research design, offering valuable insights and recommendations for educators and instructional designers.

4 Results

This section presents the study’s main findings derived from the analysis of participants’ survey responses, feedback from 3 members of the collegian coaching group who observed the sessions, and the facilitator’s self-reflection. The results provide insights into the effectiveness of the CCAF framework in promoting learners’ engagement to maximize learning in synchronous online workshops.

4.1 Participants Survey Responses

The participant’s responses to the survey questions revealed several key insights into their perceptions and experiences with the CCAF framework during the workshop:

- Engagement: Figure 1 shows the distribution of the respondent’s opinions on how engaged they were in the learning activities throughout the workshop. Most participants reported being engaged in the workshop, with a majority indicating that they were either “very engaged” or “somewhat engaged” throughout the session.



Fig. 1. How engaged were you in the learning activities throughout the workshop?

– Critical Thinking: Figure 2 presents participants' perceptions on to what extent did the activities in this workshop challenge them to think critically and deeply about the content. Participants generally felt that the workshop activities challenged them to think critically and deeply about the content. However, some suggested that the scenarios used in the group activities could be more complex.



Fig. 2. To what extent did the activities in this workshop challenge you to think critically and deeply about the content?

– Feedback: Figure 3 depicts participants' perceptions of the extent to which the feedback they received helped them understand their strengths and areas for improvement. Most participants found the feedback provided during the workshop helpful in understanding their strengths and areas for improvement. However, there were a few who felt neutral or somewhat not satisfied with the feedback received.

– Confidence: Figure 4 shows participants' responses to the question on how confident they feel in applying the knowledge and skills they learned in the workshop to real-world situations. Participants reported varied confi-



Fig. 3. To what extent did the feedback you received help you understand your strengths and areas for improvement?

dence levels in applying the knowledge and skills learned in the workshop to real-world situations, with most feeling “very confident” or “somewhat confident”.



Fig. 4. How confident do you feel in your ability to apply the knowledge and skills you learned in this workshop to real-world situations?

- Satisfaction: Figure 5 suggests that overall, participants were satisfied with the workshop promoting their engagement and learning, with most indicating that they were “very satisfied” or “somewhat satisfied”.

4.2 Collegian Coaching Group Observations

The feedback provided by the three members of the collegian coaching group who observed the sessions highlighted the following key observations:

- CCAF Framework: The colleagues agreed that the CCAF framework effectively promoted engagement, collaboration, and learning among the partic-



Fig. 5. How would you rate your overall satisfaction with the workshop in terms of promoting your engagement and learning?

ipants.

- Participation: While the colleagues noted that the participants were actively engaged in the discussions, they also suggested that some participants could have been more involved in the conversation.
- Challenges: The colleagues observed minor technical issues related to Zoom tools and recommended exploring additional ways to facilitate participant feedback.

4.3 Facilitator's Self-Reflection

The facilitator's self-reflection revealed several important insights:

- Planning: The facilitator noted that implementing the CCAF framework effectively required substantial planning, including the design of the workshop, materials, and activities.
- Engagement: The facilitator observed that the participants were interested and engaged in the workshop, despite some technical issues with the Zoom collaborative tools.
- Scenarios: The facilitator acknowledged the participants' concerns regarding the complexity of the scenarios used in group activities and recognized that more challenging scenarios could have further promoted collaboration.

5 Discussion

This section discusses the interpretation of the findings, implications for instructional design and facilitation, limitations of the study, and recommendations for future research.

5.1 The Interpretation of Findings

The interpretation of the findings from this study sheds light on the effectiveness of the CCAF framework in promoting learners' engagement to maximize learning in synchronous online workshops. The participants' survey, colleague observations, and the facilitator's self-reflection provide a comprehensive understanding of the strengths and areas for improvement in implementing the CCAF framework.

Most participants reported being engaged in the workshop, indicating that the CCAF framework effectively captured and maintained their interest. This finding is essential to online learning, as engaged learners are more likely to actively participate, collaborate, and retain the knowledge gained during the learning process [61, 28, 7]. While participants generally felt that the workshop activities challenged them to think critically, some suggested that the scenarios used in group activities could have been more complex. This finding highlights the importance of designing learning activities that push learners to think deeply about the content and apply their knowledge to diverse and challenging situations, which is in line with works in [12, 45, 31, 14]. These activities enhance critical thinking and prepare learners for real-world problem-solving.

The findings reveal that feedback played a crucial role in helping participants understand their strengths and areas for improvement. Most participants found the feedback during the workshop helpful, but a few felt neutral or somewhat unsatisfied with it. This result suggests that providing timely, specific, and constructive feedback facilitates learning and growth, consistent with the findings in [72, 27, 52]. In addition, the varied levels of confidence reported by participants in applying the knowledge and skills learned in the workshop to real-world situations emphasize the need to design activities that build self-efficacy. Therefore, incorporating practical, real-life scenarios and allowing learners to practice and apply their knowledge can boost their confidence and prepare them for real-world challenges.

The participants' overall satisfaction with the workshop indicates that the CCAF framework successfully promoted engagement and learning. However, it is essential to continually evaluate and refine the learning experience to ensure continued satisfaction and effectiveness. This result is consistent with related studies in [67, 4, 56] that investigated using the CCAF framework in various learning settings.

Moreover, the feedback from colleagues and the facilitator's self-reflection provided valuable insights into the strengths and areas for improvement in implementing the CCAF framework. The colleagues' observations highlighted the need for greater participation, addressing technical challenges, and exploring additional ways to facilitate participant feedback. The facilitator's self-reflection emphasized the importance of planning, acknowledging participants' concerns regarding the complexity of the scenarios, and addressing technical issues with collaboration tools.

In summary, the findings of this study demonstrate that the CCAF framework effectively promoted learners' engagement to maximize learning in syn-

chronous online workshops. However, there are areas for improvement, such as enhancing the complexity of group activities, addressing technical challenges, and ensuring effective feedback. These insights can guide future instructional design and facilitation efforts to enhance learners' learning experience and outcomes in synchronous online workshops.

5.2 Implications for Instructional Design and Facilitation

The findings of this study have significant implications for instructional design and facilitation in synchronous online workshops. Educators and instructional designers can refine their approaches to enhance learner engagement and learning outcomes by understanding the strengths and areas for improvement in implementing the CCAF framework.

A critical aspect of instructional design is the development of activities that effectively engage learners. The study findings suggest that the CCAF framework successfully promotes engagement, but there is room for improvement in the complexity and variety of activities. Designers should consider incorporating more challenging and diverse activities that push learners to think critically and apply their knowledge in novel ways. The study also highlights the importance of fostering collaboration among learners. Facilitators should encourage participants to engage in group activities actively, provide opportunities for peer-to-peer feedback, and offer support when needed. Addressing technical challenges and providing alternative options for collaboration tools can also enhance the collaborative learning experience.

Providing timely, specific, and constructive feedback facilitates learning and growth. Facilitators should focus on offering feedback that helps participants understand their strengths and areas for improvement. Encouraging participants to provide feedback to each other and the facilitator can also enhance the learning experience and promote a growth mindset. Similarly, instructional designers should consider incorporating practical, real-life scenarios and allowing learners to practice and apply their knowledge. This consideration can help build participants' confidence and self-efficacy, preparing them for real-world challenges.

The study underscores the importance of continually evaluating and refining the learning experience to ensure continued satisfaction and effectiveness. Facilitators should gather feedback from participants, colleagues, and self-reflection to identify areas for improvement and implement changes accordingly. Further, in synchronous online workshops, facilitators should be prepared to adapt and adjust their instructional strategies based on the needs and preferences of the participants. This preparation may involve modifying activities, addressing technical issues, or providing additional support to learners.

The findings highlight the importance of thorough planning in designing and facilitating synchronous online workshops. Facilitators should consider every aspect of the workshop, including the structure, materials, activities, and possible technical issues, to ensure a smooth and engaging learning experience. In general, the implications of this study for instructional design and facilitation emphasize

the importance of engaging activities, effective collaboration, constructive feedback, building confidence, continuous evaluation and improvement, adaptability, and attention to detail. Educators and instructional designers can enhance learners' learning experience and outcomes in synchronous online workshops by considering these implications.

5.3 Limitations of the Study

The study has a few limitations. One of these limitations is the limited sample size. The study was conducted with a relatively small number of participants (16) and three members of the collegian coaching group observing the teaching session, which may not provide a comprehensive representation of the effectiveness of the CCAF framework in various settings and with diverse learners. A larger sample size could potentially offer more generalizable results.

Another limitation of the study is the single workshop context. The study focuses on a single workshop on the Fundamentals of Cyber Security for Cloud Computing. This specific context may limit the applicability of the findings to other subject areas or learning environments. Also, the study relies on self-reported participant data through survey responses, which may be subject to social desirability bias or inaccuracies in self-assessment. Observational data or objective measures of learning outcomes could provide more reliable insights.

Despite these limitations, the study provides valuable insights into the effectiveness of the CCAF framework in promoting learners' engagement to maximize learning in a synchronous online workshop. Future research could address these limitations by exploring larger and more diverse samples, different subject areas, and objective measures of learning outcomes.

5.4 Recommendations for Future Research

Based on the findings and limitations of the current study, the following recommendations can be made for future research. Future research could aim to include larger and more diverse samples of participants to increase the generalizability of the findings. Studies could be conducted across various educational settings, disciplines, and learner populations to better understand the CCAF framework's applicability. Also, future research could examine the adaptability of the CCAF framework for various learning environments, such as asynchronous online learning, blended learning, or face-to-face instruction, to determine its effectiveness across different instructional modalities.

Another recommendation for future research is to investigate the long-term impact of the CCAF framework on learners' engagement, collaboration, and learning outcomes. This recommendation would help determine whether the framework has lasting effects on the learners' ability to apply the acquired knowledge and skills in real-world situations. Also, objective measures of learning outcomes can be explored to complement self-reported data. These measures can include assessments, quizzes, or project evaluations, to provide a more accurate picture of the impact of the CCAF framework on learners' performance.

Future research can also investigate the individual components of the CCAF framework and their interactions to identify areas for further optimization and improvement. In addition, future research could examine the adaptability of the CCAF framework for various learning environments, such as asynchronous online learning, blended learning, or face-to-face instruction, to determine its effectiveness across different instructional modalities as well as explore the role of technology in facilitating or hindering engagement and collaboration in synchronous online workshops using the CCAF framework. This research could include examining the effectiveness of different collaborative tools and platforms and identifying best practices for their integration into the instructional design.

6 Conclusion

In conclusion, this study aimed to investigate the effectiveness of the CCAF framework in promoting learners' engagement to maximize learning in a synchronous online workshop on the Fundamentals of Cyber Security for Cloud Computing. The study's findings revealed that the CCAF framework effectively engages learners, promotes critical thinking, fosters collaboration, and enhances learning outcomes. Participants generally expressed satisfaction with the workshop, and most were likely to recommend it to others.

The study contributes to the field by providing valuable insights into using the CCAF framework in the context of synchronous online workshops, particularly in cyber security and cloud computing education. The findings suggest that careful planning, incorporating diverse and challenging scenarios, and incorporating technology to support collaboration can enhance learners' engagement and learning experience. Moreover, the study highlights the importance of timely and constructive feedback in facilitating learners' understanding and applying the acquired knowledge and skills.

While the study has limitations, including the small sample size and self-reported data, it provides a solid foundation for future research. Future research could explore the CCAF framework's adaptability to different learning environments and instructional modalities, investigate the long-term impact of the framework on learners' performance, and examine the role of technology in enhancing or hindering engagement and collaboration.

This study's findings underscore the CCAF framework's potential to improve the quality of online learning experiences, particularly in synchronous online workshops. It is a valuable starting point for educators and instructional designers looking to enhance engagement, collaboration, and learning outcomes in their online learning environments. As online and hybrid learning continues to evolve and gain prominence, the CCAF framework can play a critical role in shaping effective and engaging learning experiences for learners across disciplines and contexts.

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