

# The Effects of Students towards Computer Science Learning Activities through Hybrid Service Learning

Umi Mastura Abd Majid\*, Noor Azean Atan

Faculty of Educational Sciences and Technology, Universiti Teknologi Malaysia, Johor, Malaysia  
Email: \*u.mastura@graduate.utm.my

**How to cite this paper:** Majid, U. M. A., & Atan, N. A. (2025). The Effects of Students towards Computer Science Learning Activities through Hybrid Service Learning. *Open Journal of Social Sciences*, 13, 724-743. <https://doi.org/10.4236/jss.2025.133048>

**Received:** March 5, 2025

**Accepted:** March 23, 2025

**Published:** March 26, 2025

Copyright © 2025 by author(s) and Scientific Research Publishing Inc.

This work is licensed under the Creative Commons Attribution International License (CC BY 4.0).

<http://creativecommons.org/licenses/by/4.0/>



Open Access

## Abstract

The lack of learning activities to practice the transition from theory to practice has resulted in students being less capable of conceptualising the knowledge acquired in real-life situations and mastering generic skills. Therefore, learning Computer Science requires an approach that incorporates real-world applications, such as through the implementation of Service Learning activities. However, in the post-COVID-19 endemic phase, the full implementation of Service Learning activities in a face-to-face setting is not entirely feasible. Hence, the integration of Service Learning activities through technological mediums is crucial in Computer Science education. A hybrid approach to Service Learning activities that utilises technological platforms serves as an instructional design strategy that provides students with opportunities to apply theoretical knowledge in real-world practice. Consequently, this study has designed a Computer Science learning activity that incorporates graphic materials through a hybrid Service Learning website to support the enhancement of generic skills and assess students' perceptions. Based on a quasi-experimental research design, a total of 27 students participated in this study. The research data were analysed descriptively by examining students' levels of generic skills across three phases: before, during, and after the implementation of Service Learning. Meanwhile, students' perceptions indicated positive feedback towards hybrid Service Learning.

## Keywords

Hybrid Service Learning, Service Learning, Generic Skills

## 1. Introduction

In the rapidly evolving landscape of globalisation and digitalisation, higher edu-

cation in Malaysia is placing greater emphasis on the development of generic skills to equip graduates with the necessary competencies to compete internationally. Generic skills encompass a broad range of abilities essential for performing diverse tasks across various contexts, including communication, problem-solving, critical thinking, and teamwork. To reinforce these skills, the hybrid service learning approach has been introduced as an innovative pedagogical strategy in higher education institutions. This approach integrates conventional and online learning with service-learning activities that engage students in community-based projects, allowing them to gain hands-on experience (Chan & Wong, 2023).

The primary objective of the hybrid service learning model is to bridge the gap between theoretical knowledge and practical application by actively involving students in real-world community initiatives. This approach enables students to not only acquire academic knowledge but also cultivate vital generic skills. For instance, students engaged in community-driven service-learning projects develop the ability to collaborate effectively with diverse stakeholders, address real-world challenges, and enhance their communication skills. Research by Che Noh et al. (2022) suggests that students who participate in service learning exhibit higher levels of generic skills than those who follow a traditional curriculum without such engagement.

In Malaysia, the hybrid service learning approach has garnered increasing attention from both universities and the government. Numerous initiatives have been launched to incorporate this approach into higher education curricula. According to the Ministry of Higher Education Malaysia (2018), programmes integrating service learning have demonstrated significant effectiveness in improving educational quality and fostering students' generic skills. This initiative aligns with the Malaysia Education Blueprint (Higher Education) 2015-2025 (KPM, 2015), particularly its first key thrust, which focuses on enhancing students' learning experiences. The blueprint underscores the necessity of promoting experiential and community-based learning to develop essential 21st-century skills while simultaneously leveraging technology to offer personalised learning experiences tailored to students' needs. Likewise, the incorporation of computer-based technology in student learning has become increasingly important, as highlighted in Higher Education 4.0 (Ministry of Higher Education Malaysia, 2018; Rincon-Flores et al., 2024). However, to provide students with authentic learning experiences through the integration of technology and digital platforms, it is crucial to design learning activities with well-structured methods and strategies.

The adoption of hybrid learning in computer science, particularly through the use of graphic services, has significantly contributed to the enhancement of students' generic skills. One of the most notable benefits is the improvement of communication skills. A study conducted by Heidi Hyytinen et al. (2023) found that students involved in such activities demonstrated greater clarity and effectiveness in communication, particularly when conveying complex computer science concepts to peers and mentors. Furthermore, the approach has been shown to foster

students' critical thinking abilities. By engaging in problem-solving tasks and data analysis exercises, students are provided with practical opportunities to refine these skills. Research by [Wong & Lau \(2023\)](#) revealed that students who participated in hybrid graphic service learning outperformed their counterparts in critical thinking assessments compared to those who underwent traditional learning methods.

In summary, the hybrid service learning model holds immense potential for strengthening generic skills among university students in Malaysia. By combining theoretical learning with practical experience and promoting active involvement in community-based projects, this approach not only enhances students' academic competencies but also nurtures their overall personal and professional development. Therefore, expanding the adoption of this approach within the higher education sector is vital to ensuring that Malaysian graduates are well-prepared, competitive, and capable of tackling future challenges ([Che Noh et al., 2022](#); [Heidi Hyytinen et al., 2023](#); [KPM, 2015](#); [Lorenzo & Lorenzo, 2020](#); [Netwong et al., 2023](#); [Nsamba, 2019](#); [Tomczyk, 2020](#)).

## 2. Research Background

Prior studies have highlighted ongoing challenges in Computer Science education, particularly concerning students' depth of knowledge and proficiency in generic skills. These difficulties persist due to the instructional approach, which offers limited opportunities for students to apply theoretical concepts in real-world contexts. Additionally, many students face challenges in understanding the logical foundations of Computer Science concepts and often struggle with unclear learning content ([Atan et al., 2021](#)). Generic skills, which serve as an essential component in human capital development, remain underdeveloped as they are not sufficiently integrated into Computer Science education. Research by [Culcasi et al. \(2022\)](#) and [Yu et al. \(2023\)](#) indicates that students' generic skills can be evaluated from multiple perspectives, depending on the specific course they undertake. However, the inadequate emphasis on these skills within teaching practices may hinder students from gaining a more comprehensive grasp of their studies.

To enhance students' learning experiences in Computer Science, the use of graphic-based instructional materials as visual representations of real-world situations has been identified as a valuable strategy. Applying learning concepts to practical settings allows students to gain hands-on experience and deepen their understanding. According to research conducted by [Petersen et al. \(2023\)](#) and [Marcus et al. \(2021\)](#), the development of an interactive learning ecosystem in Computer Science can significantly enhance students' comprehension of key concepts.

Likewise, [Yang & Wang \(2023\)](#) stress the importance of providing clearer visual representations in Computer Science education to improve learning outcomes. Their study, which explored the integration of visual elements in programming education, demonstrated that this method enhances students' ability to grasp

complex concepts, engage in problem-solving, and develop critical skills. Similarly, research by [Ngai et al. \(2023\)](#) found that many students encounter difficulties in solving learning tasks and often struggle to conceptualise abstract theories without clear visualisation and real-world experiences. Therefore, incorporating graphical elements into learning can improve students' cognitive processing by linking visual representation with real-life problem-solving ([Rodrigues, 2022](#)). Moreover, the integration of web-based technologies is seen as an effective approach to reinforcing students' understanding and enhancing their generic skills, thereby addressing some of the challenges in Computer Science education ([Getenet et al., 2024](#)).

The implementation of graphical content within learning systems has been proven to be highly effective in improving students' clarity of understanding ([Netwong et al., 2023](#)). Consequently, designing meaningful learning environments requires the use of graphical representations that reflect real-world situations, ensuring that students gain a more comprehensive perspective during their learning process ([Faranak Sahraie et al., 2024](#)). Additionally, students benefit from authentic and practical learning experiences that enable them to apply their knowledge in real-life contexts while refining their generic skills ([Marcus et al., 2021](#)). To further enhance their comprehension and skill development, students should be engaged in learning activities that provide opportunities to apply theoretical knowledge to real-world problems. One effective method is service learning, which integrates real-world applications with theoretical instruction, allowing students to develop valuable hands-on experience ([Andrés-Romero et al., 2022](#); [Culcasi et al., 2022](#)).

### 3. Research Objectives

The objectives of this study are as follows:

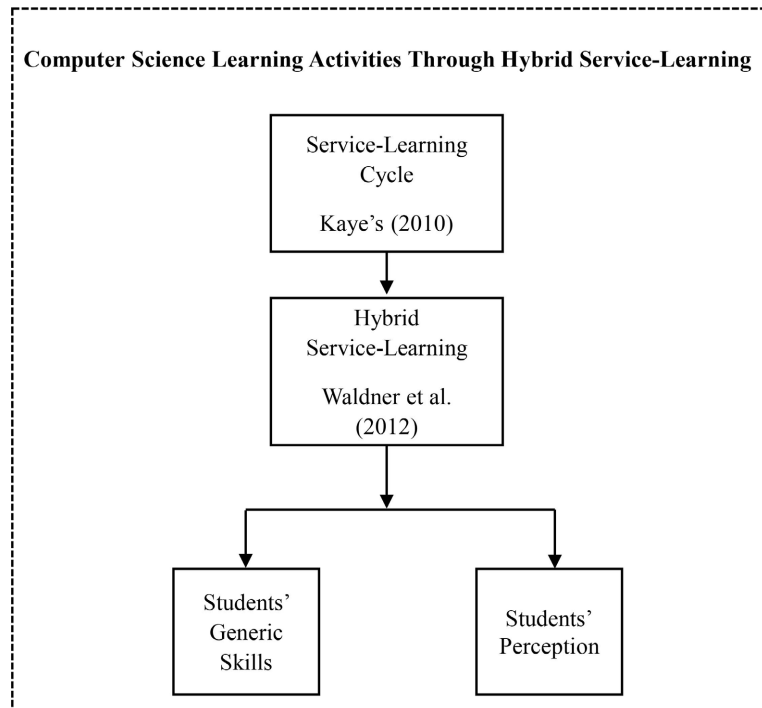
- a) To identify the impact of Computer Science learning activities through hybrid service-learning with graphics on students' generic skill levels.
- b) To examine students' perceptions of Computer Science learning activities through hybrid service-learning with graphics.

### 4. Research Framework

The research framework ([Figure 1](#)) is based on the service-learning strategy proposed by [Kaye \(2010\)](#) and the hybrid service-learning approach introduced by [Waldner et al. \(2012\)](#). This learning activity incorporates graphical materials through a web-based learning platform during the implementation of service-learning with the community.

### 5. Student Service-Learning Activities

Referring to preliminary studies on previous service-learning, data were collected to assess their level of achievement in undertaking the Computer Science (Computer Networks) course through conventional methods at higher education



**Figure 1.** Research framework for graphic-based service-learning activities.

institutions, as well as conducting service-learning projects as their community subject. **Table 1** presents the students' skill levels through service-learning activities, revealing that their skill levels in service-learning activities, measured through pre- and post-activities, were at a moderate level.

**Table 1.** Students' skill levels in service-learning activities.

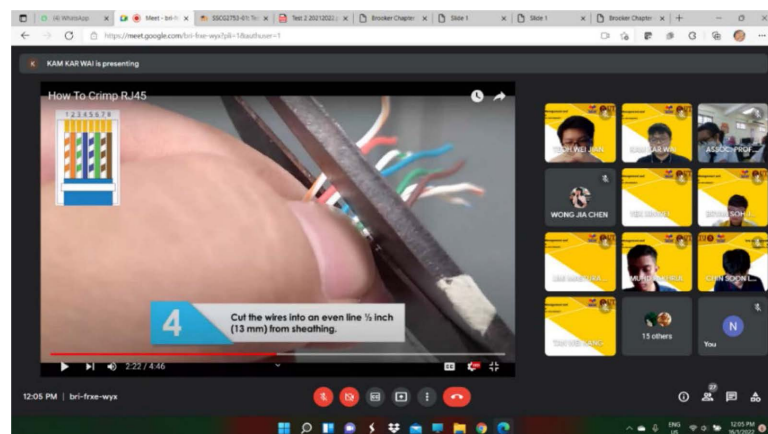
	Adaptability (25%)	Global Citizen (25%)	Scholarship (25%)	Leadership and Teamworking Skills (25%)
Pre-activity (mean)	10.5	11.18	10.5	11.5
Post-activity (mean)	12	14	13.5	13
Difference	1.5	2.82	3	1.5

Therefore, this study develops computer science learning activities encompassing all aspects related to the design of learning activities with graphic materials through hybrid service-learning, which incorporates five service-learning strategies: investigation, preparation, action, demonstration, and reflection. During service-learning, Google Meet was used as the medium to conduct hybrid service-learning with the community. The ADDIE instructional design model was selected to structure the development framework for hybrid service-learning, involving five phases: analysis, design, development, implementation, and evalua-

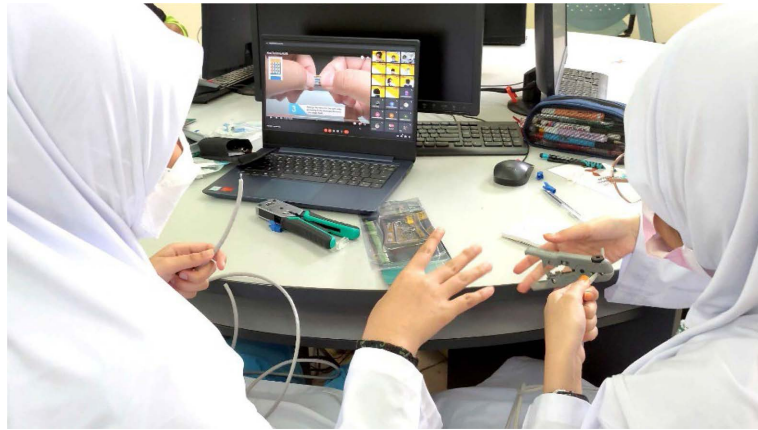
tion. The implementation of service-learning activities is based on five phases: Phase One—Investigation, Phase Two—Preparation, Phase Three—Action, Phase Four—Reflection, and Phase Five—Demonstration. These phases refer to the service-learning strategies proposed by *Kaye (2010)* and are integrated through web technology known as Hybrid Service-Learning III. This approach involves conducting service-learning activities both face-to-face and via the web, as outlined by *Waldner et al. (2012)*. Student learning activities were conducted over six weeks, while service-learning activities with the community were implemented from weeks ten to fifteen through the hybrid service-learning approach. The following **Table 2** provides a detailed explanation of the development of the learning activities.

**Table 2.** Detailed service-learning activities over 6 weeks.

Week	Topic	Learning Activities	Phase Service Learning
10	Wireless Network	Activity 1: Pre-Proposal Draft Activity 2: Post-Proposal Draft	Investigation
11	Community Needs Analysis	Activity 3: Pre-design of Learning Modules (Video, book & Kit Tools) Activity 4: Post-design of Learning Modules (Video, book & Kit Tools)	Preparation
12	Community Project	Activity 5: Pre-Service Learning	Action
13	Implementation	Activity 6: Post-Service Learning	
14	Community Project Report	Activity 7: Pre-Learning Documentation and Post-Learning Documentation	Reflection and Demonstration
15		Activity 8: Pre-Report and Presentation and Post-Report and Presentation	



**Figure 2.** During service-learning student activities with hybrid service learning.



**Figure 3.** During hybrid service-learning activities with community combine hybrid and face-to-face.

Referring to **Figure 2** and **Figure 3**, it illustrates the service-learning activities being conducted with the community and integrated through web technology, known as hybrid service-learning III. This approach involves the implementation of service-learning activities both face-to-face and via the web, as stated by **Waldner et al. (2012)**.

## 6. Methodology

This research employs a quantitative research design using a quasi-experimental method with a one-group pre-test and post-test approach, incorporating both quantitative and qualitative data collection. The rationale for adopting this approach is that quantitative data and analysis provide only a general understanding of the research problem. In contrast, qualitative data and analysis offer a more detailed explanation of the findings by exploring participants' perspectives in depth, as supported by previous studies (**Cohen et al., 2011**; **Creswell, 2009**). The combination of quantitative and qualitative data strengthens the research findings and provides a more comprehensive understanding of a social phenomenon. In this study, quantitative data were collected first to gain an initial insight into the research focus, followed by qualitative data collection to validate and further reinforce the findings.

### Population and Sample of the Study

The population of this study consists of undergraduate students enrolled in the ICT for Community course, which incorporates service-learning at a higher education institution. A total of 27 students from a single class section in Semester I participated in the study. The sampling method used in this study is the purposive sampling technique. The sample includes both local and international students. Furthermore, nine individuals participated in a concise interview session. This research specifically concentrated on a Computer Science course, which was executed with prior consent from the academic faculty.

## 7. Findings

The results of data analysis through the mean score of pre-task and post-task in Service-Learning activities on students' mastery of generic skills were based on the graduate attributes that need to be mastered in learning after the intervention. However, in this study, only four generic skills were assessed throughout the course: Scholarship, Leadership and Teamworking Skills, Adaptability, and Global Citizenship. A total of 27 students participated in the Computer Networking course. **Table 3** below presents the distribution of student learning activities.

**Table 3.** Distribution of student learning activities.

Service Learning Activities	Generic Skills	Pre-Taks	Post-Task
Before	Scholarship, Leadership and Teamworking Skills, Adaptability	Service Learning Preparation	Service Learning Preparation
During	Leadership and Teamworking Skills, Adaptability, Global Citizen	Service Learning Project	Service Learning Project
After	Leadership and Teamworking Skills, Adaptability, Global Citizen	Final Report and Presentation	Final Report and Presentation

**Table 4.** Generic skills score marks.

Score	Level
5 - 6	Good
3 - 4	Moderate
1 - 2	Weak

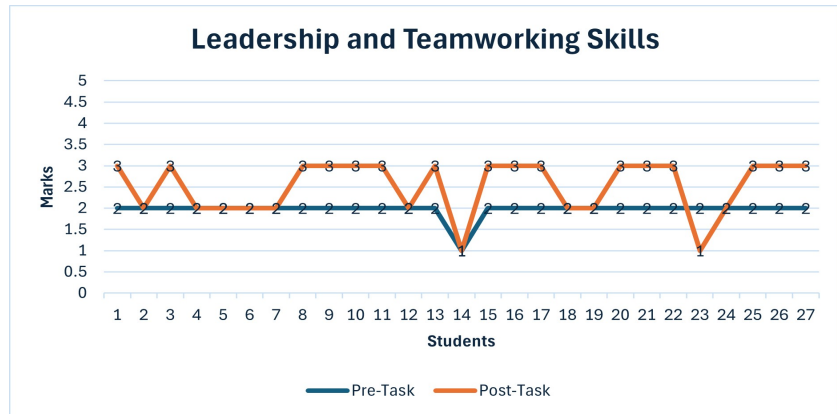
Based on **Table 4**, the score marks evaluate students' generic skills demonstrated before, during, and after the service-learning activities. Scores ranging from 5 to 6 indicate a good level, scores from 3 to 4 represent a moderate level, and scores from 1 to 2 indicate a weak level. The measure for the improvement of student activities is shown in **Table 5** below.

**Table 5.** Measure for student activities.

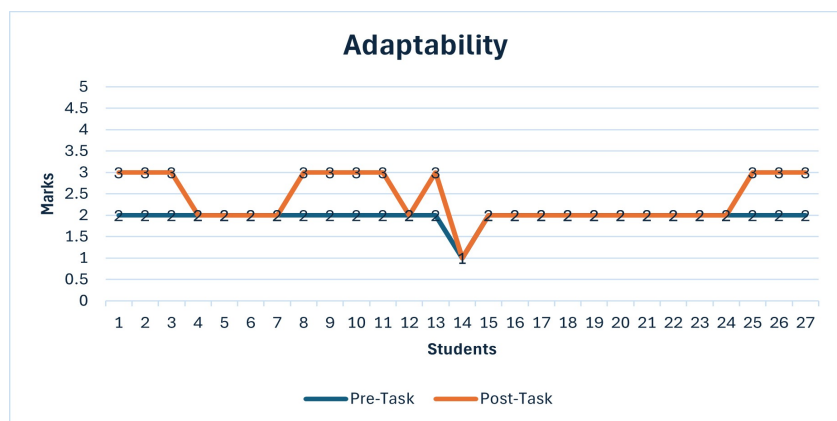
Score	Level	Indicator
A	Increased	↑
B	Remained	↔
C	Decreased	↓

### 7.1. Pre- and Post-Analysis of Data before Service-Learning Activities

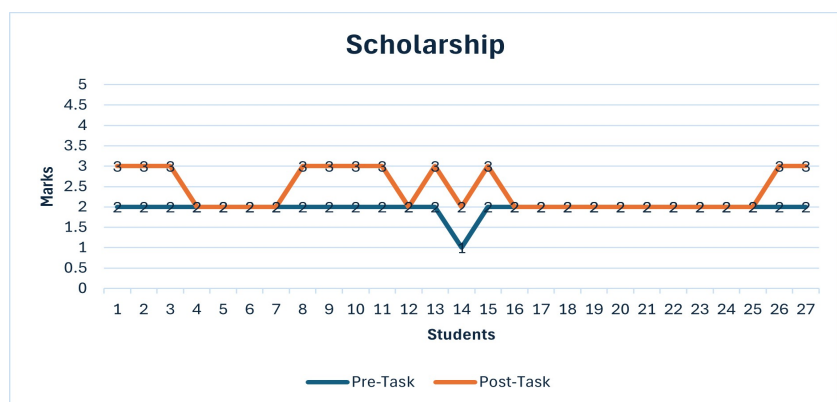
Figure 4 presents the data analysis from the assessment of activities preparation service learning each other before the Service-Learning implementation through pre-task and post-task evaluations, focusing on students' generic skills, namely Scholarship, Leadership and Teamworking Skills, and Adaptability.



(a)



(b)



(c)

Figure 4. Students' generic skills before service learning.

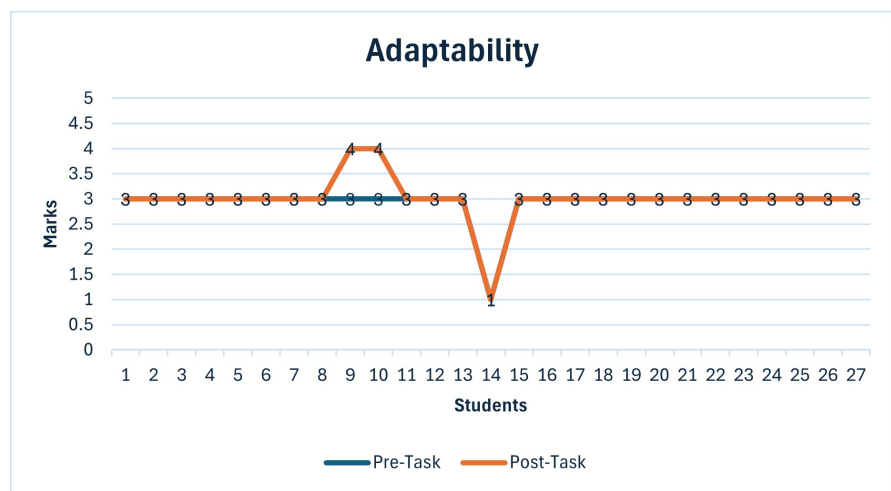
**Table 6.** Summary of the total pre-task and post-task before service-learning for students.

Level	Score	Indicator	Total Number of Students
Good	A	↑	12
Moderate	B	↔	14
Weak	C	↓	1

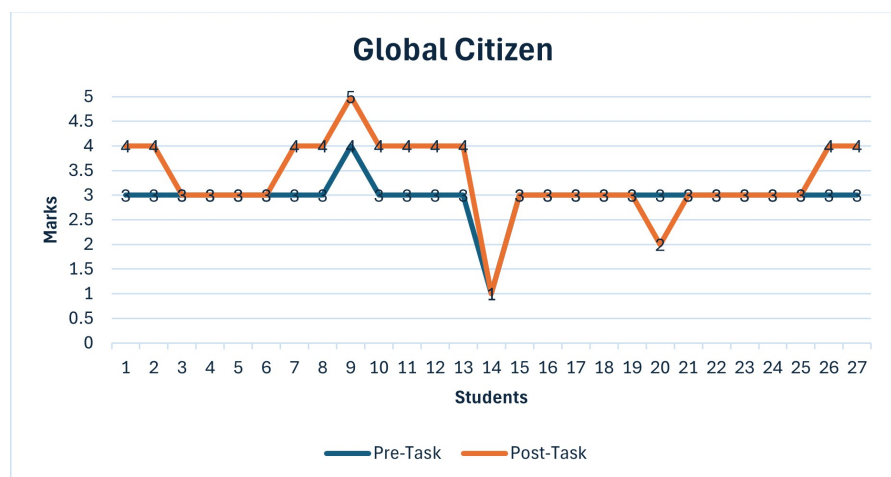
Based on **Table 6**, it was found that 12 students achieved a good level of generic skills, 14 students were at a moderate level, and only one student demonstrated a weak level of generic skills.

## 7.2. Pre and Post Data Analysis during Service-Learning Activity

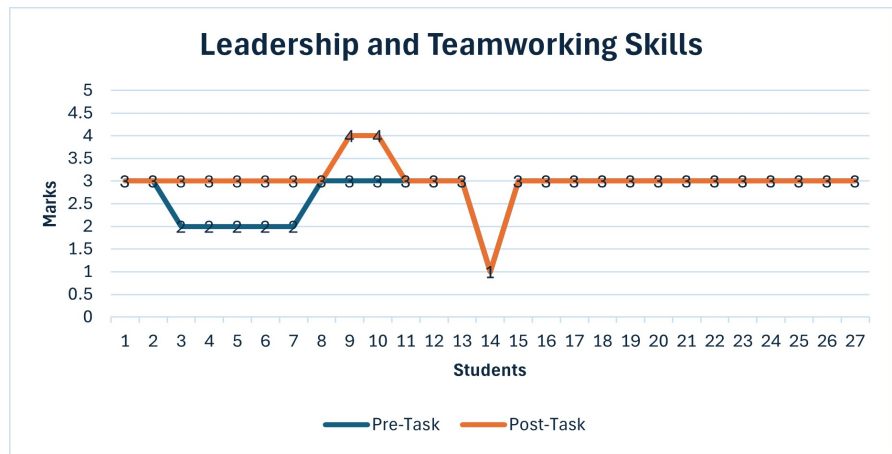
Next, **Figure 5** presents the data analysis results from the evaluation of activities conducted during Service-Learning project through pre-task and post-task assessments, focusing on students' generic skills, namely Leadership and Teamworking Skills, Adaptability, and Global Citizenship.



(a)



(b)



(c)

Figure 5. Students’ generic skills during service learning.

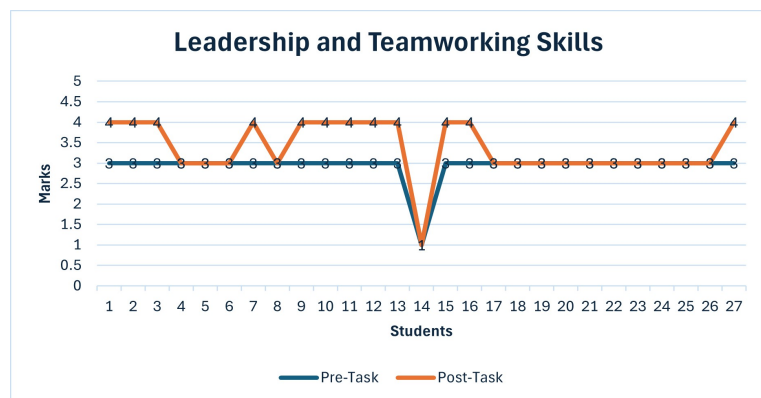
Table 7. Summary of the total pre-task and post-task during service-learning for students.

Level	Score	Indicator	Total Number of Students
Good	A	↑	3
Moderate	B	↔	23
Weak	C	↓	1

Table 7 presents a summary of the overall mean score for the level of generic skills during the implementation of Service-Learning. The results show that 3 students achieved a good level of generic skills, the majority of 23 students attained a moderate level, and one student demonstrated a weak level of generic skills.

### 7.3. Pre and Post Data Analysis after Service-Learning Activity

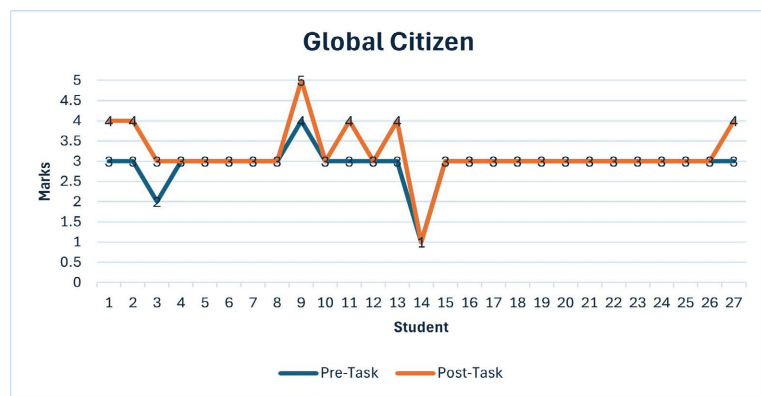
Figure 6 presents the data analysis from the assessment of activities conducted after the Service-Learning through final report and presentation pre-task and post-task evaluations, focusing on students’ generic skills, namely Leadership and Teamworking Skills, Adaptability, and Global Citizen.



(a)



(b)



(c)

Figure 6. Students’ generic skills after service learning.

Table 8. Summary of the total pre-task and post-task after service-learning for students.

Level	Score	Indicator	Total Number of Students
Good	A	↑	7
Moderate	B	↔	19
Weak	C	↓	1

Table 8 presents a summary of the overall scores for the level of generic skills after the implementation of Service-Learning. A total of 7 students achieved a good level of generic skills, 19 students attained a moderate level, while only one student demonstrated a weak level of generic skills.

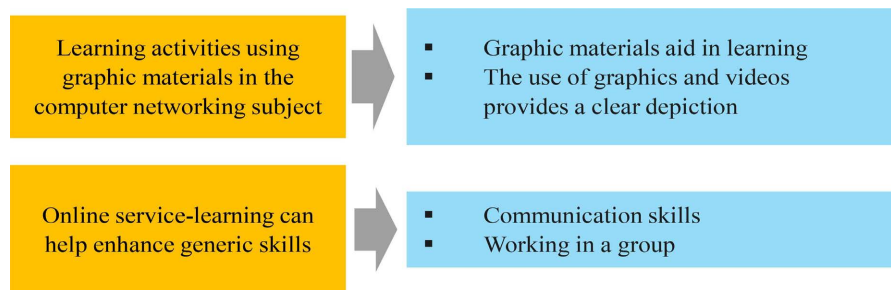
Based on the overall data analysis above, it can be concluded that there is an improvement in students’ generic skills through pre-task and post-task assessments conducted before, during, and after Service-Learning. However, only one student showed a decline in generic skills after the Service-Learning activity. Therefore, to further strengthen this data analysis, students’ perceptions were gathered regarding hybrid service-learning activities in supporting their mastery of generic skills using a graphic learning website.

#### 7.4. Descriptive Analysis of Students' Perception of Hybrid Service-Learning with Graphic

The following are the findings from the questionnaire and interview sessions conducted to support the survey data and obtain students' direct perceptions of learning through the graphic website in the computer networking course. The interviews focused on questions related to the use of the website during hybrid service-learning. **Table 9** presents students' perceptions of hybrid service-learning, while **Figure 7** summaries the coding of student response themes.

**Table 9.** Descriptive analysis of students' perception of hybrid service-learning with graphic.

No.	Item	Mean
1	Service-learning tasks through the graphic learning website enhance my understanding.	4.85
2	Service-learning tasks using graphic materials can provide me with learning experience.	4.78
3	Service-learning tasks help me apply learning concepts to real-world problems.	4.67
4	Service-learning tasks help me transfer learning concepts into real-world implementation.	4.74
5	Service-learning tasks allow me to share my knowledge with the community.	4.78
Total Mean		4.76



**Figure 7.** Summary of student response theme coding.

Based on **Table 9**, students' perceptions indicate that the hybrid service-learning approach through web-based learning enhances their understanding of the subject. Meanwhile, **Figure 7** presents the theme coding derived from student responses, revealing that the overall feedback during interviews regarding the use of graphic-based learning websites was positive. Each question posed received at least two different responses based on the conducted interviews. For the first objective, which focuses on activities involving graphical materials, two key student responses were identified: the use of graphical materials aids learning, and graphics and videos provide a clearer understanding during lessons. The second

objective relates to online service-learning, where students reported that this learning method significantly helps in developing generic skills, such as communication skills and teamwork. Overall, most students expressed positive views regarding the use of graphic-based websites in the computer networking course. The interview findings further conclude that learning through graphic-based websites enhances students' mastery of generic skills through the service-learning activities conducted.

## 8. Discussion

Based on the study findings in **Table 4**, the score marks for students' mastery of generic skills were assessed through four key skills: Scholarship, Leadership and Teamworking Skills, Adaptability, and Global Citizen. The table presents the proficiency grades of these four generic skills acquired by students through service-learning activities conducted within the community. Referring to **Figure 4** and **Table 6**, it was found that 12 students attained a high level of generic skills, while 14 students achieved a moderate level. This indicates that pre-service learning activities provided students with the opportunity to further strengthen their generic skills while enhancing their knowledge (Salhi & Qbadou, 2020).

**Figure 5** and **Table 7** display the results of the pre-test and post-test assignments during the service-learning phase, representing the mastery of generic skills in Leadership and Teamworking Skills, Adaptability, and Global Citizen. Based on these findings, only three students demonstrated high proficiency in generic skills, whereas 23 students attained a moderate level. Similar to the studies by Santos Rego et al. (2021) and Basri et al. (2022), these findings indicate that generic skills can be developed through service-learning activities, as students apply the concepts they have learned in real-world situations.

However, according to **Figure 6** and **Table 8**, the mastery of generic skills—including Leadership and Teamworking Skills, Adaptability, and Global Citizen—suggests that the majority of students attained either high or moderate proficiency levels after completing the service-learning activities. The service-learning approach provided students with valuable learning experiences, enabling them to develop their generic skills effectively. These findings align with the studies conducted by Lohberger & Braun (2022), Uotila et al. (2023), and Muukkonen et al. (2022), which highlight the effectiveness of service-learning in fostering skill acquisition.

Overall, students demonstrated a positive improvement in mastering all four generic skills—Scholarship, Leadership and Teamworking Skills, Adaptability, and Global Citizen—through service-learning activities. However, only one individual showed a decline in generic skills using hybrid service learning engagement learning. This study's findings are consistent with Lee (2024), who concluded that service-learning enhances student engagement and skill development, particularly among those with limited prior participation. Additionally, research by Harrell et al. (2024), Iniesto & Rodrigo (2024), and Baabdullah et al. (2024) supports the

integration of service-learning into Computer Science education, as it fosters the development of generic skills and facilitates the practical application of theoretical concepts to real-world problem-solving.

From the students' perspective, the study suggests that web-based learning with graphical materials effectively supports their learning process. This is consistent with the findings of [Sola-Guirado et al. \(2024\)](#) and [Luangrungruang & Kokaew \(2022\)](#), who indicated that incorporating graphical materials into learning helps students translate theoretical concepts into practice and positively influences their overall learning experience. Moreover, student interview responses reinforce that hybrid service-learning with graphical materials can be implemented in real-world contexts. This is in line with studies by [Winarti et al. \(2021\)](#) and [Wahyuningsih et al. \(2021\)](#), which found that the integration of graphical materials within service-learning activities enhances students' mastery of generic skills.

To further support these perceptions, student feedback collected through surveys and interviews also indicated a positive response towards the use of graphic-based web learning, as reflected in the following student statements:

- 
- S2: "...This ICT subject has helped me to develop a higher level of self-confidence. Previously, I was a bit shy... This subject requires a high level of cooperation between one another..."
- S8: "...The use of this website is very helpful as it makes it easier for us as students to stay updated on what we are going to learn..."
- 

Consequently, the enhancement of students' academic performance in the domain of Computer Science education has been empirically substantiated through their proficient mastery of generic skills via service-learning initiatives, as evidenced by the results of this investigation. The implementation of hybrid graphic service-learning functions as an educational conduct, thereby augmenting the efficacy of the instructional and learning processes. This aligns with the study by [Huang and Qi \(2025\)](#), which states that the use of graphic materials in Computer Science learning methods can enhance students' interest and improve their academic achievement.

## 9. Conclusion

Referring to the discussion outlined, a total of eight learning activities were conducted over six weeks in the actual study with students. The implementation of these learning activities was based on generic skills through the graphic service-learning web platform, which was designed to assess students' mastery of generic skills during the service-learning process. According to the study findings, all students involved in the learning process focused on the content of the Computer Networking course and showed a significant improvement in their generic skills. However, one study demonstrated a decline in the development of generic skills and engagement in learning. Most students successfully mastered all four generic

skills—Scholarship, Leadership and Teamworking Skills, Adaptability, and Global Citizen—through service-learning activities integrated with hybrid graphic service-learning.

To ensure the effectiveness of learning through hybrid service-learning, the application of graphic materials is essential, as highlighted in studies by Aslam Katahman and Fakri Othman (2021), Asilah Anuar & Hafizah Adnan (2021), and Nur and Halim (2020), which demonstrate positive impacts on students. By using hybrid graphic service-learning and engaging in service-learning activities, students are able to visualise the learning concepts in real-world contexts, aligning with the findings of Yusof et al. (2019) and Salhi and Qbadou (2020), which suggest that Computer Science education is well-suited to hybrid service-learning graphic. Additionally, the implementation of service-learning activities provides students with meaningful learning experiences and enhances their real-world knowledge.

The implementation of a hybrid service-learning model among larger academic cohorts across various disciplines constitutes a viable initiative. However, it encompasses several critical challenges that require strategic solutions. The flexibility of this model allows its application across fields such as Social Sciences, Humanities, and Health Sciences, with a curriculum design that is adaptive and aligned with discipline-specific educational objectives. Technological resources can facilitate coordination and assessment mechanisms, thereby enhancing the scalability of the model. Nevertheless, issues, such as insufficient resource distribution, the complexities of establishing and sustaining community partnerships, the assurance of quality standards, the management of complex assessment methodologies, and the maintenance of student engagement, represent major challenges. Effectively addressing these challenges requires meticulous planning, a robust technological framework, and strong collaboration with community stakeholders to ensure the successful achievement of educational objectives and service outcomes.

## Acknowledgements

This work was supported/funded by Ministry of Higher Education Malaysia under Fundamental Research Grant Scheme (FRGS/1/2023/SSI07/UTM/02/24).

## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

## References

- Andrés-Romero, M. P., Fernández-Torres, M., & Salvador-Ferrer, C. (2022). Impact of the E-Service-Learning Methodology in University Students during COVID-19: Does It Encourage Teamwork and Innovation? *Electronic Journal of Research in Educational Psychology*, 20, 613-634. <https://doi.org/10.25115/ejrep.v20i58.5987>
- Asilah Anuar, N., & Hafizah Adnan, N. (2021). *Kesan Penggunaan Video Animasi Dalam Kursus Pengaturcaraan Java Bagi Pelajar IPTA* (Vol. 3). Effect of Using Animated Video in Learning Java Programming for Students in Public Universities.
- Aslam Katahman, M., & Fakri Othman, M. (2021). The Development of Augmented Real-

- ity Application for Introduction of Data Structure. *Applied Information Technology and Computer Science*, 2, 364-377. <https://doi.org/10.30880/aitcs.2021.02.02.025>
- Atan, N. A., Tasir, Z., Ali, M. F., Rosli, M. S., & Mohamad Said, M. N. H. (2021). Students' Performance and Perceptions towards Authentic Learning Environment Based on Visual Thinking Continuum. *International Journal of Emerging Technologies in Learning (ijET)*, 16, 56-73. <https://doi.org/10.3991/ijet.v16i23.27455>
- Baabdullah, A., Alajlan, H., & Alebaikan, R. (2024). The Perceptions and Experiences of In-Service Teachers in a Computer Science Professional Development Program. *Sustainability*, 16, Article 1473. <https://doi.org/10.3390/su16041473>
- Basri, M., Arif, S., Heryandi, H., & Sinaga, R. M. (2022). Prospective Teachers, Generic Skills, and Student Community Service Program: A Case Study in the Indonesian Context. *WSEAS Transactions on Environment and Development*, 18, 80-89. <https://doi.org/10.37394/232015.2022.18.9>
- Chan, C. K., & Wong, H. Y. (2023). Students' Perception of Written, Audio, Video and Face-to-Face Reflective Approaches for Holistic Competency Development. *Active Learning in Higher Education*, 24, 239-256. <https://doi.org/10.1177/14697874211054449>
- Che Noh, C. H., Ibrahim, M. Y., Ismail, I. R., Abas, M. M., Abdullah, N. A. C., & Abd Aziz, N. A. (2022). The Relationship between the Use of E-Learning and Students' Communication Competencies at Universiti Malaysia Terengganu. *EDUCATUM Journal of Social Sciences*, 8, 24-36. <https://doi.org/10.37134/ejoss.vol8.sp.3.2022>
- Cohen, L., Manion, L., & Morrison, K. (2011). *Research Methods in Education* (7th ed.). Routledge.
- Creswell, J. W. (2009). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches* (3rd ed.). Sage Publications.
- Culcasi, I., Russo, C., & Cinque, M. (2022). E-Service-Learning in Higher Education: Modelization of Technological Interactions and Measurement of Soft Skills Development. *Journal of Higher Education Outreach and Engagement*, 26, 39-56. <https://www.scopus.com/inward/record.uri?eid=2-s2.0-85144933502&partnerID=40&md5=d63297174ba7f04128002a8fa251b2d3>
- Getenet, S., Haeusler, C., Redmond, P., Cante, R., & Crouch, V. (2024). First-Year Preservice Teachers' Understanding of Digital Technologies and Their Digital Literacy, Efficacy, Attitude, and Online Learning Engagement: Implication for Course Design. *Technology, Knowledge and Learning*, 29, 1359-1383. <https://doi.org/10.1007/s10758-023-09724-z>
- Harrell, R. A., Lentz, S., Robledo Yamamoto, F., Volda, A., & Barker, L. (2024). Putting the Service into Service Learning: A Report on a Survey of CS Faculty. In *Proceedings of the 55th ACM Technical Symposium on Computer Science Education* (pp. 470-476). ACM. <https://doi.org/10.1145/3626252.3630910>
- Huang, H., & Qi, D. (2025). Is MOOC Really Effective? Exploring the Outcomes of MOOC Adoption and Its Influencing Factors in a Higher Educational Institution in China. *PLoS ONE*, 20. <https://doi.org/10.1371/journal.pone.0317701>
- Hyttinen, H., Tuononen, T., & Braun, E. (2023). Editorial: Generic Skills in Higher Education. *Frontiers in Education*, 8, Article 1162156. <https://doi.org/10.3389/educ.2023.1162156>
- Iniesto, F., & Rodrigo, C. (2024). Exploring the Accessibility Evaluation of City Council Websites by Computer Science Students Using a Service-Learning Approach. In *Proceedings of the XXIV International Conference on Human Computer Interaction* (pp. 1-4). ACM. <https://doi.org/10.1145/3657242.3658591>

- Kaye, C. B. (2010). The Complete Guide to Service Learning: Proven, Practical Ways to Engage Students in Civic Responsibility, Academic Curriculum, & Social Action. In *The Complete Guide to Service Learning* (p. 256). Free Spirit Publishing Inc.
- KPM (2015). *Pelan Pembangunan Pendidikan Malaysia 2015-2025 (Pendidikan Tinggi)*. Kementerian Pendidikan Malaysia.
- Lee, P. B. Y. (2024). A Mixed-Method Study to Investigate the Relevance of International Service-Learning to University Students' Perspectives on Ethnic Diversity. *International Journal of Educational Research Open*, 7, Article 100371. <https://doi.org/10.1016/j.ijedro.2024.100371>
- Lohberger, K., & Braun, E. (2022). Comparing Learning Opportunities of Generic Skills in Higher Education to the Requirements of the Labour Market. *Frontiers in Education*, 7, Article 886307. <https://doi.org/10.3389/educ.2022.886307>
- Lorenzo, C., & Lorenzo, E. (2020). Opening up Higher Education: An E-Learning Program on Service-Learning for University Students. In *Advances in Intelligent Systems and Computing* (pp. 27-38). Springer International Publishing. [https://doi.org/10.1007/978-3-030-20135-7\\_3](https://doi.org/10.1007/978-3-030-20135-7_3)
- Luangrungruang, T., & Kokaew, U. (2022). E-Learning Model to Identify the Learning Styles of Hearing-Impaired Students. *Sustainability*, 14, Article 13280. <https://doi.org/10.3390/su142013280>
- Marcus, V. B., Atan, N. A., Yusof, S. M., & Mastura, U. (2021). Students' Perception towards Engaging Factors of Extreme E-Service Learning Design for Computer Network Course. *International Journal of Interactive Mobile Technologies (ijIM)*, 15, 100-115. <https://doi.org/10.3991/ijim.v15i05.20901>
- Ministry of Higher Education Malaysia (2018). *Framing Malaysian Higher Education 4.0 Future-Proof Talents*. Ministry of Higher Education Malaysia.
- Muukkonen, H., Lakkala, M., Ilomäki, L., & Toom, A. (2022). Juxtaposing Generic Skills Development in Collaborative Knowledge Work Competences and Related Pedagogical Practices in Higher Education. *Frontiers in Education*, 7, Article 886726. <https://doi.org/10.3389/educ.2022.886726>
- Netwong, T., Pijitkamnerd, B., & Chuayrodmod, S. (2023). The Development of an E-Service Learning Model for Promoting a Digital Active Learning Community of Mainstreaming Students in Higher Education. *Journal of Multidisciplinary in Social Sciences*, 19, No. 3. <https://www.scopus.com/inward/record.uri?eid=2-s2.0-85180882513&partnerID=40&md5=723a1a907b913d1b20253715d2d60167>
- Ngai, G., Lau, K., & Kwan, K. (2023). A Large-Scale Study of Students' E-Service-Learning Experiences and Outcomes during the Pandemic. *Journal of Experiential Education*, 47, 29-52. <https://doi.org/10.1177/10538259231171852>
- Nsamba, A. (2019). Maturity Levels of Student Support E-Services within an Open Distance E-Learning University. *The International Review of Research in Open and Distributed Learning*, 20, 61-78. <https://doi.org/10.19173/irrodl.v20i4.4113>
- Nur, A. R., & Halim, N. D. A. (2020). Effect of Inquiry Based Learning with Video Integration towards Students' Achievement in Learning Mathematics. *Innovative Teaching and Learning Journal*, 3, No. 2.
- Petersen, G. B., Stenberdt, V., Mayer, R. E., & Makransky, G. (2023). Collaborative Generative Learning Activities in Immersive Virtual Reality Increase Learning. *Computers & Education*, 207, Article 104931. <https://doi.org/10.1016/j.compedu.2023.104931>

- Rincon-Flores, E. G., Castano, L., Guerrero Solis, S. L., Olmos Lopez, O., Rodríguez Hernández, C. F., Castillo Lara, L. A. et al. (2024). Improving the Learning-Teaching Process through Adaptive Learning Strategy. *Smart Learning Environments*, 11, Article No. 27. <https://doi.org/10.1186/s40561-024-00314-9>
- Rodrigues, A. L. (2022). Integrating Digital Technologies in Accounting Preservice Teacher Education. *International Journal of Technology and Human Interaction*, 18, 1-19. <https://doi.org/10.4018/ijthi.293200>
- Sahraie, F., Rezvanfar, A., Movahedmohammadi, S. H., Ebner, M., Alambeigi, A., & Farrokhnia, M. (2024). Analysis of Learners' Emotions in E-Learning Environments Based on Cognitive Sciences. *International Journal of Interactive Mobile Technologies (ijIM)*, 18, 34-52. <https://doi.org/10.3991/ijim.v18i07.48471>
- Salhi, I., & Qbadou, M. (2020). Student Learning Communities' Detection Based on Betweenness Centrality Algorithm: Validation and Optimization. In *2020 1st International Conference on Innovative Research in Applied Science, Engineering and Technology (IRASET)* (pp. 1-5). IEEE. <https://doi.org/10.1109/iraset48871.2020.9092051>
- Santos Rego, M. A., Mella Núñez, Í., Naval, C., & Vázquez Verdera, V. (2021). The Evaluation of Social and Professional Life Competences of University Students through Service-Learning. *Frontiers in Education*, 6, Article 606304. <https://doi.org/10.3389/educ.2021.606304>
- Sola-Guirado, R. R., Comino, F., & Castro-Triguero, R. (2024). Enhancing Self-Regulated Learning in Engineering Education with Lightboard Videos as a Support Tool. *Computer Applications in Engineering Education*, 32, e22756. <https://doi.org/10.1002/cae.22756>
- Tomczyk, L. (2020). Experiences with E-Learning as a Challenge for the Effective Training of Future Generations of Teachers. *ICCE 2020 28th International Conference on Computers in Education, Proceedings*, 1, 628-633. <https://www.scopus.com/inward/record.uri?eid=2-s2.0-85099457821&partnerID=40&md5=db77db63768e014ad142f1ba0dde1afb>
- Uotila, U., Keskiniva, K., Junnonen, J., & Saari, A. (2023). Developing Engineering Students' Generic and Professional Skills through a Consultative Approach to Project-Based Learning. *European Journal of Engineering Education*, 49, 667-682. <https://doi.org/10.1080/03043797.2023.2286329>
- Wahyuningsih, S., Qohar, A., Satyananda, D., & Atan, N. A. (2021). The Effect of Online Project-Based Learning Application on Mathematics Students' Visual Thinking Continuum in Covid-19 Pandemic. *International Journal of Interactive Mobile Technologies (ijIM)*, 15, 4-17. <https://doi.org/10.3991/ijim.v15i08.21565>
- Waldner, L. S., Mcgorry, S. Y., & Widener, M. C. (2012). E-Service-Learning: The Evolution of Service-Learning to Engage a Growing Online Student Population. *Journal of Higher Education Outreach and Engagement*, 16, 123-150.
- Winarti, A., Almubarak, A., & Saadi, P. (2021). Visual Learning Style-Based Chemistry Mental Model Representation through Transformative Online Learning. *Journal of Physics: Conference Series*, 2104, Article 012023. <https://doi.org/10.1088/1742-6596/2104/1/012023>
- Wong, M. M. L., & Lau, K. H. (2023). E-Service-Learning Is Equally Effective as Traditional Service-Learning in Enhancing Student Developmental Outcomes. *Interactive Learning Environments*, 32, 4443-4457. <https://doi.org/10.1080/10494820.2023.2200817>
- Yang, F., & Wang, H. (2023). Tracking Visual Attention during Learning of Complex Science Concepts with Augmented 3D Visualizations. *Computers & Education*, 193, Article 104659. <https://doi.org/10.1016/j.compedu.2022.104659>

Yu, L., Du, M., & Zhou, X. (2023). E-Service-Learning during the COVID-19 Pandemic: The Experiences of Mainland Chinese Students Enrolled at a University in Hong Kong. *Sustainability*, 15, Article 9211. <https://doi.org/10.3390/su15129211>

Yusof, A., Atan, N. A., Harun, J., & Doulatbadi, M. (2019). Developing Students Graduate Attributes in Service Learning Project through Online Platform. In *Proceedings of the International Conference on Industrial Engineering and Operations Management* (pp. 3524-3537). IEOM Society International.