EPiC Series in Built Environment
Volume 7, 2026, Pages 31–40
Proceedings of Associated Schools of Construction 62nd Annual International Conference

Enhancing Construction Management Facilities: A Delphi Study of Student Perspectives

Anthony Perrenoud[1]
[1]Boise State University

This study identifies twenty key elements that can enhance construction management education facilities, based on a Delphi survey conducted with 41 graduating seniors. The findings emphasize the critical importance of technological infrastructure, including sufficient power outlets, docking stations, and large monitors, as well as immersive learning tools such as BIM labs, analog MEP systems, and simulators. These features support experiential, industry-aligned training, fostering greater engagement and practical skills among students. Additionally, the research highlights the significance of social and well-being spaces, like study lounges, coffee bars, and quiet zones, which are essential for promoting student mental health and community building. It underscores the value of participatory design approaches that involve students and stakeholders in tailoring learning environments to meet actual needs. Overall, the integration of technology, hands-on experiential opportunities, and supportive social spaces contributes to enhanced student satisfaction, engagement, and readiness for the construction industry. The study provides actionable insights for faculty and administrators looking to optimize future construction education facilities by balancing innovation, functionality, and community support.

Keywords: Construction Education, Learning Environments, Student Input

Introduction

Environmental factors play a critical role in educational success; however, there is a noticeable gap in understanding which building elements most effectively support the learning environments of construction management students. While existing research emphasizes the importance of classroom design and amenities, few studies have systematically explored the overall features that cater to the needs of future construction professionals. This study aims to fill that gap by using insights from students who have experienced a construction education program. The findings can provide valuable information for faculty and administration to enhance the physical spaces of Construction Management and Science (CMS) facilities.

In 2025, Boise State University began construction on new educational facilities. To ensure that the facility improved the student experience, a Delphi study was conducted with 41 graduating seniors. These students were completing their education in a construction program, making them well-qualified to provide input on potential educational enhancements that could improve construction education today. The study identified twenty unique enhancements that could increase student satisfaction with their surroundings at the university level. This paper presents these twenty items in ranked order according to student feedback and offers insights into how the facility can be improved.

Review of Literature

A review of literature related to CMS education reveals a fragmented discussion regarding enhancements to construction facilities, including topics like active learning spaces and technology integration. Research indicates that incorporating active learning spaces in CMS buildings can significantly enhance both individual and group learning (Farrow and Wetzel, 2021). Additionally, immersive and up-to-date technology has been shown to improve the learning experiences of CMS students (Besiktepe et al., 2024; Wang et al., 2024; Shirazi & Behzadan, 2013; Perdomo et al., 2005).

However, a gap in the literature was identified concerning comprehensive methods for enhancing CMS education facilities. Looking beyond CMS literature, a systematic review by Leijon et al. (2024) highlighted that the field is broad yet fragmented, with many aspects remaining under-researched and under-theorized. The review noted that the Journal of Learning Spaces published most research on enhancing learning spaces and underscored the various themes, methods, and perspectives used to understand the complex relationships between learning spaces and student learning (Leijon et al., 2024).

Research indicates that the design of physical spaces has a significant impact on student learning and engagement (Brooks, 2012; Cotner et al., 2013). A recurring theme is the comparison between traditional spaces and innovative, flexible environments or active learning classrooms, suggesting that dynamic and interactive settings could bolster the learning experience for construction management students. Furthermore, the literature emphasizes that simply relocating to a new space does not guarantee improved learning outcomes; the perceptions of both students and teachers regarding learning spaces are crucial (Clinton & Wilson, 2019; Perks et al., 2016). Students have also expressed a preference for flexible and quiet study areas (McLaughlin & Faulkner, 2012), indicating the need for diverse learning environments within CMS facilities. Attention to seating arrangements, movable furniture, and lighting can also positively influence student perceptions (Beckers et al., 2016b).

Finally, the design process itself is pivotal, with studies stressing the importance of involving both students and academics in the design and evaluation of learning spaces (Han et al., 2014; Lee & Tan, 2013). This participatory approach can improve communication and mitigate tension among stakeholders, ensuring that the learning environment aligns with the needs and preferences of construction management students and faculty. Ultimately, a well-designed space can create a unique learning experience, as people, space, and objects become interwoven (Leijon et al., 2024).

Research Objectives and Methodology

The goal of this study was to solicit input from CMS students regarding building elements and features that could significantly enhance the learning environment of a new educational facility for the construction program. Using a Delphi study methodology, the author engaged 41 senior-level CMS students within a dedicated building designed to support their academic and practical learning. The primary objectives were twofold: first, to gather specific input from CMS students on features that would enhance their learning experience; and second, to develop a consensus among the students regarding the relative importance of these identified features.

Over the course of one month, the author engaged 41 senior construction management students enrolled in a capstone course in a structured, iterative process that spanned four rounds. This approach ensured a comprehensive and collaborative identification of facility enhancements aimed at improving their learning experience. Questionnaires were developed using Qualtrics, an online survey tool, or as individualized forms tailored to each participant based on their prior responses. Each questionnaire was administered individually to eliminate any potential group bias. The following section outlines the three rounds of the Delphi methodology, and Figure 1 provides a framework for the four-round Delphi process.

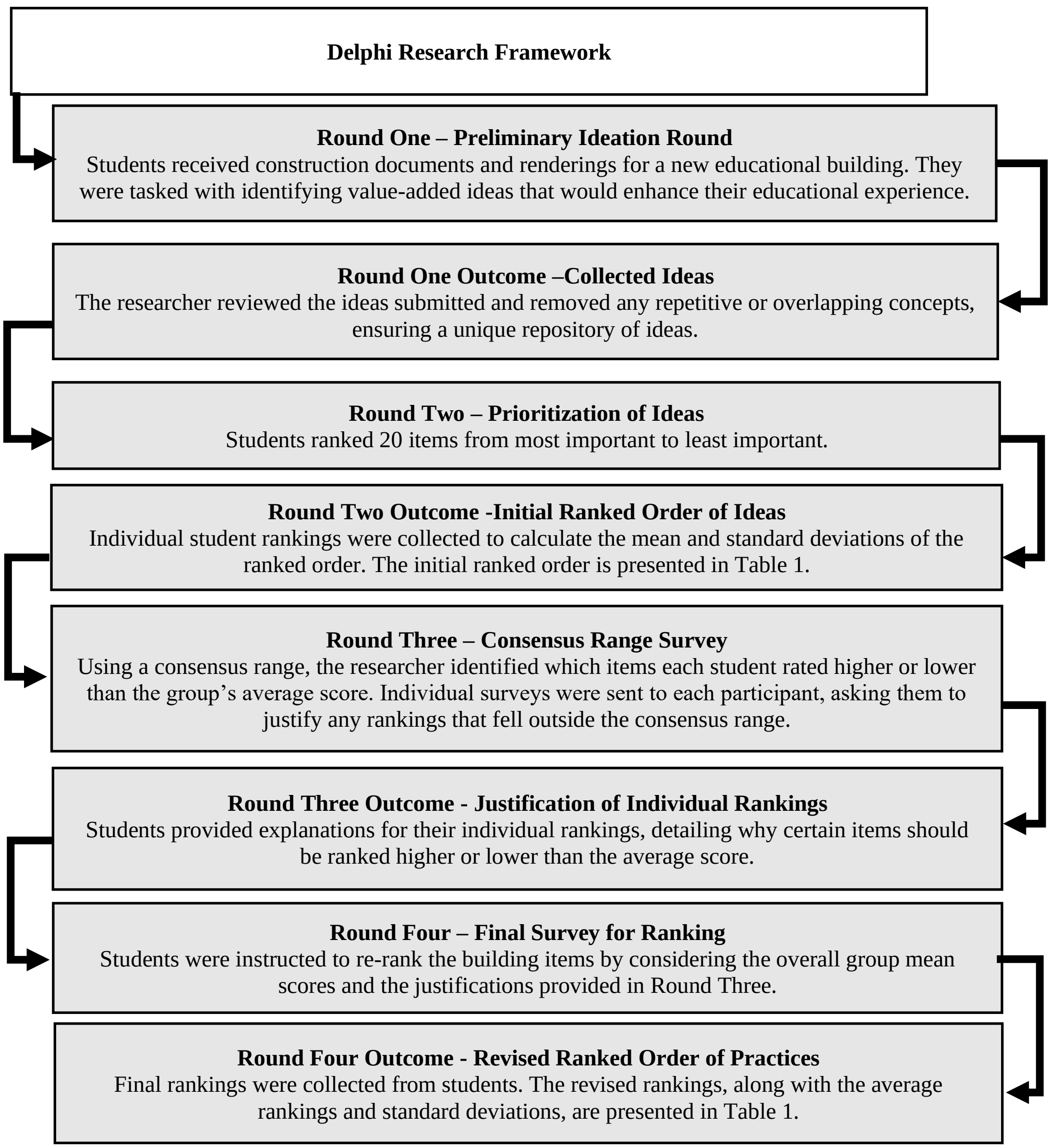

Figure 1: Delphi Research Framework

Round One
In the initial round, students were asked to brainstorm and list potential features that could enhance their educational environment. The researcher reviewed these ideas and removed repetitive or overlapping concepts, creating a concise repository of unique suggestions. This collective exercise resulted in 20 distinct features, each described succinctly, forming the basis for evaluation in the subsequent rounds.

Round Two
In the second round, these 20 features were presented back to the participants, who ranked the items according to their perceived importance. This process led to the establishment of a ranked order for the items, which can be seen in Table 1.

Round Three
The initial rankings were compiled, and personalized surveys were generated for each student. Each survey included the group's average scores for the items, alongside the individual scores, highlighting how each participant's responses aligned with or differed from the average. The survey identified the items for which individuals scored higher or lower than the group's consensus, defined by quartiles. Quartiles segment the data into three parts: the lower quartile, the median (representing the consensus range), and the upper quartile. By utilizing the consensus range, the researcher was able to pinpoint which items participants rated differently from the group's average. If a participant rated an item higher or lower than the group, they were prompted to justify their rankings, encouraging thoughtful reflection and re-evaluation of their priorities.

Round Four
In the final round, the justifications provided by all students were compiled and shared. Participants then re-ranked the features, considering the group's consensus and the justifications. This aimed to further refine the list, achieving collective agreement on the importance of each feature.

This four-round Delphi technique, characterized by iterative surveys and feedback, was instrumental in gaining a nuanced understanding of the elements that most effectively contribute to enhancing educational facilities for students in construction management.

Results

Using the four-round Delphi method, the 41 graduating students reached a consensus on the ranked order of items to enhance the new CM facility. The table below lists the 20 items identified in the Delphi study. The first three columns following the items provide data from Round Four of the study, including: 1. The ranked order of the items; 2. The average ranking of the items; and 3. The standard deviation of the rankings for each item. The subsequent data reflects the same information from earlier Round Two of the Delphi study. A visual comparison between Round Two and Round Four demonstrates an increased consensus among the items. The average standard deviation for the items in Round Two was 4.645, while in Round Four it decreased to 3.320. This reduction in the overall standard deviation indicates a greater consensus among the students.

Table 1: Ranked Order of Building Elements for enhancing education

	Round 4 Final Result			Round 2 Results		
Building Element	**Rank Order**	**Mean**	**SD**	**Rank Order**	**Mean**	**SD**
Ample Power Outlets	1	2.39	3.043	1	2.85	3.009
Computer Lab - Docking Station	2	2.95	2.141	2	4.46	3.603
Computer Lab – Dual/Large Monitors	3	4.37	3.191	3	6.34	5.030
Computers in Study Areas	4	6.61	2.853	4	7.68	3.679
Exposed MEP Systems in the Wall	5	6.83	3.185	5	8.29	4.639
BIM Lab/Room	6	7.95	2.955	6	8.73	4.793
CM Building Project Timeline	7	9.71	3.125	7	9.80	4.974
Smart/Active Whiteboards	8	10.05	3.629	9	11.85	5.842
Job/Internship Board	9	10.41	4.768	8	10.93	4.651
HVAC Building Dashboard	10	11.46	4.066	11	12.73	4.505
Heavy Equipment simulator	11	11.73	3.217	10	12.15	5.732
Coffee Bar/Maker	12	13.17	3.581	12	12.76	5.230
Trade Simulator/VR Lab	13	13.54	3.908	14	13.22	5.121
Material Library/Showcase	14	13.61	3.608	13	13.15	5.390
Game table in the Study Lounge area	15	15.05	3.078	16	13.93	4.936
Drafting Tables	16	15.20	3.888	15	13.66	4.320
Rolling plan table/job box	17	16.95	2.378	17	15.83	4.282
Home-Away-From-Home Facilities	18	18.32	1.920	18	17.00	4.585
Mini-Market	19	19.17	4.588	19	17.34	4.786
Job Trailer Room	20	19.68	3.279	20	17.44	3.794
Total Average			**3.320**			**4.645**

Discussion

Below are the 20 elements that were identified in the Delphi study, including a short description of the elements and reasoning to incorporate them into the building.

1. Ample Power Outlets
Ensuring ample power outlets throughout the facility addresses the persistent issue of accessibility, enabling students to power diverse devices seamlessly. Participants highlighted the convenience and necessity of such infrastructure to support modern learning environments, where laptops and other digital devices are integral.

2. Computer Lab - Docking Station
Docking stations facilitate efficient workflows by allowing students to connect personal laptops to larger displays, mirroring industry practices. This setup supports personalized device use while enhancing productivity within shared lab spaces, bridging classroom learning with professional settings.

3. Computer Lab – Dual or Large Monitors
Dual monitors or large monitors enhance productivity by enabling efficient multitasking and detailed project work, such as cost controls and plan reviews. Aligning with industry standards, these monitors simulate a professional workspace, thus preparing students for real-world tasks.

4. Computers in Study Areas
Providing computers outside traditional labs increases resource accessibility, supporting students who require specific software or collaborative spaces. This flexibility fosters a conducive study environment, essential for completing assignments and projects efficiently.

5. Exposed MEP Systems in Walls
Exposing MEP systems offers a tangible learning tool that enhances comprehension of complex mechanical, electrical, and plumbing concepts. This hands-on feature helps translate theoretical knowledge into practical understanding, particularly in MEP and scheduling courses.

6. BIM Lab/Room
A dedicated BIM lab, equipped with VR, provides a cutting-edge environment for exploring Building Information Modeling. This technology facilitates in-depth understanding and engagement with 3D modeling, crucial for students as they prepare for roles in an increasingly digital industry landscape.

7. CM Building Project Timeline Display
A timeline display of the facility's construction process offers real-world insight into project sequencing and development. This educational tool serves as a visual aid in understanding scheduling dynamics and project management, instilling historical and contextual awareness in students.

8. Smart/Active Whiteboards
Smart whiteboards transform classrooms into interactive hubs, enhancing visibility and collaboration during lectures. By facilitating digital markups and real-time problem-solving, they enrich learning experiences and help students grasp complex concepts through active participation.

9. Job/Internship Board
A centralized career board is a valuable resource for student professional development, connecting them to job opportunities and internships. By raising awareness and fostering engagement, it supports career planning and networking within the construction management field.

10. HVAC Building Dashboard

An HVAC dashboard provides real-time data, valuable for understanding building operations and energy efficiency. This tool enhances learning in MEP-related subjects, linking theoretical knowledge with practical building management applications.

11. Heavy Equipment Simulator
Simulators offer students experiential learning opportunities in operating heavy machinery, critical for understanding equipment functionality and management in construction settings. This hands-on experience prepares students for practical challenges they may face in their careers.

12. Coffee Bar/Maker
A coffee bar enhances the study environment by offering a space for refreshment and social interaction. It supports students during intensive study periods, fostering community and networking in a relaxed setting.

13. Trade Simulator/VR Lab
VR technology in trade simulations offers an innovative educational platform, allowing students to engage with construction processes in a virtual environment. This hands-on tool improves understanding and visualization, aligning with modern educational trends.

14. Material Library/Showcase
A material library provides hands-on access to construction materials, bridging the gap between theory and practice. This resource aids in comprehending MEP systems and construction assemblies, enhancing tactile and visual learning.

15. Game Table in Study Lounge
A game table in the study lounge offers stress relief and a break from academic pressures, promoting mental well-being and fostering a sense of community and connection among students.

16. Drafting Tables
Drafting tables offer ergonomic and practical workspaces for handling physical plans, especially beneficial in courses that involve design and plan reading. They support visual learning and reflect real-world applications in the construction industry.

17. Rolling Plan Table/Job Box with Monitor
Mobile job boxes with monitors create flexible, collaborative work environments suitable for engaging with digital plans and BIM models, facilitating practical learning in field-like conditions.

18. Home-Away-From-Home Facilities
Quiet relaxation spaces cater to students' well-being, particularly for those with demanding schedules or long commutes. These areas support focus and productivity by allowing students to recharge between tasks.

19. Mini-Market
A mini-market provides convenient access to snacks and drinks, helping maintain energy and focus during study sessions. It also strengthens community bonds by offering a space for social interaction.

20. Job Trailer Room
A job trailer room simulates real-site conditions, preparing students for industry-specific environments and scenarios they will encounter in professional roles. This experiential setup facilitates learning through real-world simulations.

Study Limitations

While the Delphi method facilitated consensus-building among participants, this study was limited to a single graduating class at one institution. Future research should expand the sample to include multiple graduating classes across different universities to enhance the generalizability and robustness of the findings.

Conclusions

This study underscores the profound impact that thoughtfully designed physical environments have on the educational experience of Construction Management and Science (CMS) students. Through a systematic Delphi approach involving graduating seniors, the research identified twenty key building elements deemed most vital for enhancing learning spaces within new construction education facilities. The consensus achieved among students highlights several overarching themes and practical considerations for optimizing these environments.

Firstly, the importance of accessible and sufficient technological infrastructure emerged strongly, with items such as ample power outlets, docking stations, large monitors, and computers in study areas ranking highly. These features address the modern demands of digital learning and professional practice, ensuring students can seamlessly engage with industry-standard tools. The inclusion of exposed MEP systems, BIM labs, and real-time building dashboards further reflects a push towards active, experiential learning, offering tangible insights into complex mechanical, electrical, and building systems. These elements bridge theoretical knowledge with practical understanding, fostering deeper engagement.

Secondly, the emphasis on immersive and interactive educational technologies—such as heavy equipment simulators, VR trade labs, and mobile collaborative workspaces—illustrates a shift toward experiential and simulation-based learning. These facilities prepare students for real-world challenges, enhancing their technical competence and confidence. The integration of innovative spaces like smart whiteboards and project timelines also demonstrates a recognition of the evolving nature of classroom interaction, emphasizing collaboration, visualization, and contextual learning.

Thirdly, the study highlights the significance of supporting student well-being and community. Features like home-away-from-home facilities, social spaces such as coffee bars and game tables, and mini-markets cater to the holistic needs of students, promoting mental health, social connection, and sustained focus. Practical spaces including drafting tables, job trailer rooms, and flexible mobile workstations facilitate hands-on learning and simulate industry environments, ensuring that students are not only academically prepared but also acclimated to professional workflows and settings.

Overall, the findings reinforce the necessity of involving students and stakeholders alike in the design and evolution of educational facilities. Such participatory approaches can lead to spaces that are more aligned with the specific needs and preferences of future construction professionals, ultimately enhancing engagement, satisfaction, and learning outcomes. The evidence from this study advocates for a balanced integration of technological, functional, and social elements within construction education environments.

Acknowledgement

The author used AI tool ChatGPT-4o developed by OpenAI for assistance with language improvement of this manuscript. The author reviewed and edited the AI-generated content to ensure accuracy and take full responsibility for the final text.

References

Beckers, R., Van der Voordt, T., & Dewulf, G. (2016). Why do they study there? Diary research into students' learning space choices in higher education. Higher Education Research & Development, 35(1), 142–157.

Besiktepe, D., Sparkling, A., Debs, L., & Manuel, R. (2024). Digital Technology Applications in Construction Education: A Systematic Review of Methodological Pluralism. International Journal of Construction Education and Research, 20(4), 421-443.

Brooks, D. C. (2012). Space and consequences: The impact of different formal learning spaces on instructor and student behavior. Journal of Learning Spaces, 1(2).

Clinton, V., & Wilson, N. (2019). More than chalkboards: Classroom spaces and collaborative learning attitudes. Learning Environments Research, 22, 325–344.

Cotner, S., Loper, J., Walker, J. D., & Brooks, D. C. (2013). It's not you, it's the room—Are the high-tech, active learning classrooms worth it? Journal of College Science Teaching, 42, 82–88.

Farow, C. B., & Wetzel, E. (2021). An active learning classroom in construction management education: Student perceptions of engagement and learning. International Journal of Construction Education and Research, 17(4), 299–317. https://doi.org/10.1080/15578771.2020.1757536

Han, A. N. Y., Lim, C., & Nair, P. K. (2014). X-space model: Taylor's University's collaborative classroom design and process. Procedia - Social and Behavioral Sciences, 123, 272–279.

Leijon, M., Nordmo, I., Tieva, Å., & Troelsen, R. (2024). Formal learning spaces in Higher Education–a systematic review. Teaching in Higher Education, 29(6), 1460-1481.

Lee, N., & Tan, S. (2013). Traversing the design-language divide in the design and evaluation of physical learning environments: A trial of visual methods in focus groups. Journal of Learning Spaces, 2(1), 1–7.

McLaughlin, P., & Faulkner, J. (2012). Flexible spaces ... what students expect from university facilities. Journal of Facilities Management, 10(2), 140–149.

Perdomo, J. L., Shiratuddin, M. F., Thabet, W., & Ananth, A. (2005, July). Interactive 3D visualization as a tool for construction education. In 2005 6th International Conference on Information Technology Based Higher Education and Training (pp. F4B-23). IEEE.

Perks, T., Orr, D., & Al-Omari, E. (2016). Classroom re-design to facilitate student learning: A case study of changes to a university classroom. Journal of the Scholarship of Teaching and Learning, 16, 53–68.

Shirazi, A., & Behzadan, A. H. (2013, December). Technology-enhanced learning in construction education using mobile context-aware augmented reality visual simulation. In 2013 Winter Simulations Conference (WSC) (pp. 3074-3085). IEEE.

Wang, X., Chou, M., Lai, X., Tang, J., Chen, J., Kong, W. K., ... & Yam, M. C. (2024). Examining the effects of an immersive learning environment in tertiary AEC education: Cave-VR system for students' perception and technology acceptance. Journal of Civil Engineering Education, 150(2), 05023012.