

# **CDIO LEARNING SPACES IN DIGITAL TRANSFORMATION: A CASE AT VINH UNIVERSITY, VIETNAM**

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## **ABSTRACT**

In digital transformation, learning spaces are vital in enhancing education quality by creating environments that foster creativity, problem-solving skills, and hands-on experience for students. This study examines the implementation of CDIO-based education with a focus on Standard 6 - technical learning spaces, at Vinh University, Vietnam. Quantitative and qualitative methods were employed to collect data from students and faculty members. The findings indicate that while the university has made significant progress in modernising its learning spaces and integrating digital technology, there are still areas for improvement. The study concludes by proposing some solutions to improve the learning spaces to be aligned with CDIO standards and digital transformation in higher education.

## **KEY WORDS**

Learning Spaces, Blended Learning, Digital Transformation, Standard: 6

## INTRODUCTION

At every stage of education development, **technical learning space** plays a key role in improving the quality of training and developing comprehensive capacity for learners. Research by Radcliffe (2009) highlighted the importance of designing learning spaces in higher education, including classrooms, libraries and laboratories. With the development of the internet, the learning spaces include both physical and virtual environments. According to Bygstad (2022), the implementation of digital learning spaces in higher education involves three fundamental factors: 1) The alignment between digital education and digital subjects: This provides a solid technical foundation, making it easy for students to access and apply technology in learning; 2) Redefining the roles between teachers and students: Digital learning spaces allow for new and more intensive forms of learning, in which teachers play a supporting and guiding role, while students are active in acquiring knowledge and forming skills; 3) Transcending physical and institutional boundaries: These spaces enable universities to interact with the broader society, expanding the scope of education, and connecting with the community. In addition, the design of informal learning spaces in universities has also been shown to positively impact students' learning and social interaction. Physical spaces like building lobbies, corridors, and libraries are designed to encourage students to engage in self-directed learning, promoting interpersonal interaction and collaboration. In **digital transformation**, technical learning spaces are important in building and developing an advanced educational ecosystem where students can access modern technologies and develop essential skills for the digital era. Digital transformation in education is not only about applying technology but also about changing the approach to learning through restructuring **physical and digital learning spaces** to optimise the learning experience and develop learners' creative capacity. Modern technical learning spaces provide traditional facilities such as laboratories or workshops **and a digitised environment** where students can learn through **Virtual Reality (VR), 3D simulation** and interactive online learning tools. According to Dao (2019), virtual reality (VR), 3D simulation, and interactive online learning help students access knowledge more intuitively and immersively, creating an enriching and practical learning experience. Applying virtual reality and similar technologies to teaching helps improve practice and enhances students' ability to teach themselves, which is especially necessary in the digital transformation era (Tu et al., 2022). The investment and development of these spaces will bring long-term benefits to both learners and society. This paper reports a case study of CDIO implementation at Vinh university with a focus on standard 6 - technical learning spaces of the latest CDIO version 3.0.

## LITERATURE REVIEW

### *The development of Standard 6 in CDIO Version 3.0*

The CDIO initiative began from aeronautical engineering and the application of CDIO model has been still the most popular with the engineering discipline. In practice, the CDIO-based approach can be applied to other disciplines as it ensures a framework of knowledge and skills. Since its inception in the early 2000s, the CDIO initiative has been continuously improved to adapt to the changing educational and industrial environment. These improvements have greatly benefited the orientation of technical training, helping universities focus on theory and build academic programs focusing on practice and career skills development. After several versions, the current CDIO version 3.0 effectively supports the training of future engineers by developing a curriculum based on practical projects, promoting problem-solving and systems thinking. The improvements in the CDIO versions are intended

to align with the practical context and educational innovation requirements. The development of CDIO versions is shown in Table 1:

Table 1. Development of CDIO Syllabus Versions

CDIO Syllabus contents	CDIO Syllabus 1.0	CDIO Syllabus 2.0	CDIO Syllabus 2.0	CDIO Syllabus 3.0
1. Technical knowledge and reasoning	Basic Technical Knowledge	Extensive technical knowledge, including emerging fields	Translated and regionally adjusted content	Integrating advanced technology (AI, IoT)
2. Personal and professional skills and qualities	Personal and professional skills	Greater emphasis on lifelong learning and professional ethics	Focus on local vocational skills	Greater emphasis on innovation and entrepreneurship
3. Communication and teamwork skills	Teamwork and communication	Enhance communication in diverse environments	Emphasis on cultural diversity in teamwork	Global teamwork and interdisciplinary communication
4. Conceptualisation, design, implementation and operation of the system in the context of business and society	The CDIO Process in the Technical Context	Extended scope to include environmental and social impacts	Adapting the CDIO process for local businesses	Sustainability, ethics, and global impact in the CDIO process

The CDIO 3.0 set of standards (Malmqvist et al., 2020) consists of 12 closely related standards that form a framework for developing a comprehensive technical training program. These standards guide curriculum improvement, ensuring that students can develop the necessary professional skills in real-world technical environments. Of the 12 CDIO standards, Standard 6 – Technical learning spaces profoundly influences the design and construction of learning environments in modern technical training programs. For the CDIO 3.0 version, the learning spaces not only include engineering workspaces and traditional laboratories but also integrate a digital environment, such as online tools and spaces, virtual reality (VR) and 3D simulations that facilitate teaching and enhance learning effectiveness. These technologies allow students to practice safe simulation systems before performing on devices.

As Standard 6 is to create a flexible and interactive learning environment where students can develop skills through hands-on projects, it directly contributes to the implementation of Standard 5 on the design–implementation experience and Standard 7 on the integrated learning experience. Moreover, modern technical learning spaces also promote active learning methods, helping students promote creativity and problem-solving abilities, thereby meeting the practical requirements of the industry.

The construction of technical learning spaces also supports the capacity of lecturers, creating conditions for them to apply new teaching methods, thereby improving standards 9 and 10 on teaching capacity development. As a result, it makes a contribution to improving the quality of

teaching and the effectiveness of learning assessment of Standard 11 and program evaluation of Standard 12. Furthermore, the construction of appropriate technical learning spaces promotes the implementation of active learning methods of Standard 8, encouraging students to actively participate in the learning process and develop self-study skills. This improves the quality of training and prepares students to meet the increasing demands of modern industry.

### ***The impact of digital transformation on the design of technical learning spaces***

From the technical perspective, digital transformation is an organisation's shift to big data, analytics, cloud, mobile, and social media platforms (Vial, 2021). In education, integrating digital technologies such as virtual reality (VR), augmented reality (AR), and online learning platforms has opened up new educational methods, helping students access knowledge in an interactive and proactive way. For instance, using VR and AR in technical training allows students to experience real-life situations in a virtual environment, enhancing hands-on skills without any risk of virtual reality devices. Bygstad et al. (2022) analysed the transition from traditional learning methods to digital learning spaces, emphasising that digital transformation is not merely using technology but also changing how education is organised and managed. Wang and Liu (2021) also noted that digital learning spaces can promote multi-dimensional interaction and facilitate experiential learning activities. In Vietnam, Tran et al. (2022) have shown that using digital platforms such as Moodle and Microsoft Teams in online teaching improves teaching efficiency and expands educational access opportunities for students in remote areas. Regarding the design of learning spaces, Beichner (2014), with the SCALE-UP model, has proven that flexible learning spaces can effectively support positive learning methods, which enhances student participation in the classroom. Lin et al. (2019), who studied the application of virtual reality (VR) and augmented reality (AR) technologies in learning space design in Asia, concluded that these technologies not only enhance interactivity but also help improve learning outcomes.

To catch up with the trend, the Vietnamese government has developed a comprehensive digital transformation roadmap for 2025 with a vision for 2030 (Lam, 2021). Many policies have been introduced, and several major training programs on digital transformation have been implemented at different levels (Lam, *ibid.*), prioritising digital transformation in all fields, such as education and training, developing platforms to support remote teaching and learning, digitising documents, building online learning resources, etc. (Prime Minister, 2020); Ministry of Education and Training, 2022). There have also been documents guiding how to build digital learning materials and online courses on the application of the platform providing open online courses (Ministry of Education and Training, *ibid.*). Thus, digital transformation has significantly influenced the design of technical learning spaces in CDIO training in Vietnamese universities, which has created profound changes in the design of technical learning spaces towards a more flexible and efficient modern learning environment. Although there have been some studies on the design of learning spaces, there is still a lack of specific studies on combining the CDIO model and digital transformation in the design of learning spaces at Vietnam's universities. This study aims to fill the gap by exploring the design of CDIO learning spaces in the context of digital transformation, focusing on the case of Vinh University.

## **METHODS**

### ***Data Collection***

The primary data are collected from multiple sources, including survey questionnaires, interviews with stakeholders, reports of accreditation agencies, Vinh University's annual

reports, and other related documents such as proceedings of institutional conferences and faculty workshops. Field observations of learning spaces such as laboratories, labs, libraries, and shared learning areas also provide additional information for the data analysis.

### ***Research methods***

This study employs a mixed research approach including quantitative and qualitative methods to address research issues related to the design of CDIO learning spaces in digital transformation at Vinh University. The quantitative method uses questionnaires to survey the satisfaction of Vinh University's learning space in four areas: learning areas and campus landscapes, library and learning material system, practice and experiment spaces, and learning spaces integrated with digital technology. The survey subjects include faculty and students at Vinh University. The research sample was selected using a stratified random selection method, ensuring the representation of different academic disciplines. Three hundred students and 50 faculty members participated in the quantitative survey, while 20 people from these groups were selected for in-depth interviews.

### ***Evaluation and benchmarking***

The results of data analysis are evaluated and benchmarked against CDIO version 3.0 standards with a focus on Standard 6 - technical learning spaces. This comparison aims to determine the level of response of Vinh University to the requirements of the CDIO and to make appropriate proposals for improvement.

## **FINDINGS AND DISCUSSION**

### ***CDIO implementation at Vinh University***

Vinh University, one of the leading multidisciplinary universities in Vietnam, has officially implemented the CDIO-based undergraduate programs since 2017. Applying the 12 CDIO standards promotes fundamental innovation in training development and contributes to shaping the modern training approach, meeting the requirements of the Vietnam National Qualifications Framework. The CDIO training programs at Vinh University are designed to comprehensively develop students' knowledge, skills, attitudes, practical competencies and sense of social responsibility (Vinh University reports, 2022, 2023, 2024).

Based on the 12 CDIO standards, Vinh University has flexibly adjusted and implemented the specifics of the industry and the local context. Unlike institutions that only apply CDIO for engineering programs, Vinh University has expanded the scope of application to non-technical disciplines such as journalism, social work, and teacher training. The implementation of CDIO at the university is built on a foundation of active learning, encouraging students to participate deeply in the learning process through advanced methods such as project-based, flipped, and blended learning. Moreover, the university has applied digital technologies to design learning spaces, creating favourable conditions for students to optimally develop their creativity and self-learning skills.

### ***Learning spaces at Vinh University***

In order to meet the Standard 6 of CDIO 3.0, Vinh University has built modern, flexible and diverse learning spaces which include physical and virtual components. The facilities are designed to provide maximum support for teaching, research, learning and practical activities.

Physically, the university boasts two large campuses in addition to three practical premises with a total land area of over 120 hectares. The practice and experiment complex consists of 50 modern laboratories, fully equipped with advanced equipment and regularly upgraded to suit the CDIO-based training model. The library and learning resources center, the most extensive library in the North Central region, is equipped with modern facilities as well as printed and digital materials, which meets the training requirements of CDIO standards. Students can access international databases such as the Proquest Center and other digital platforms for online research and learning. Furthermore, the institution is affiliated with industry and the world of work to form a diverse learning ecosystem, which includes businesses, enterprises, and agencies, where students have the opportunity to do practicum and internship. It also has a network of 62 satellite schools for teacher training programs. The extended learning spaces help students comprehensively develop professional knowledge and skills.

Regarding learning spaces integrated with digital technology, the university has a good information technology infrastructure system to meet the needs of teaching, studying and research. The intranet system connects 15 buildings through five major transmission lines, providing high speed Gbps connection for more than 1,000 computers. In addition, the institution has installed over 250 wifi access points in key areas such as classrooms, laboratories, playgrounds, training grounds and dormitories, ensuring free internet access services for faculty and students.

To facilitate students learning, Vinh University adopts blended learning model, which comprises face-to-face classes and virtual lessons through online Learning Management System (LMS), and real-time virtual classes via Zoom, and Microsoft Teams platforms. E-learning materials are developed by the Center for Learning Resources Production equipped with modern facilities. At present, the university boasts over 20,000 e-lectures, providing abundant resources for online training programs. Since 2018, the university has adopted a blended learning model across all disciplines and types of training, in which at least 30% of the learning time and contents are flexibly implemented through the LMS system. The system integrates e-learning materials and video-recorded lectures according to appropriate scenarios and allows online formative assessment activities to keep track of students' learning. The practical application of modern technologies has helped the institution build a flexible digital learning environment, optimise learners' learning experience and improve training quality. The university also develops virtual laboratories and virtual research models, which provides students with simulated exercises and practice.

### ***Evaluation of Vinh University's learning spaces***

#### ***Faculty and students' evaluation***

The faculty and students' satisfaction with the learning area and campus landscape is shown in Figure 2:

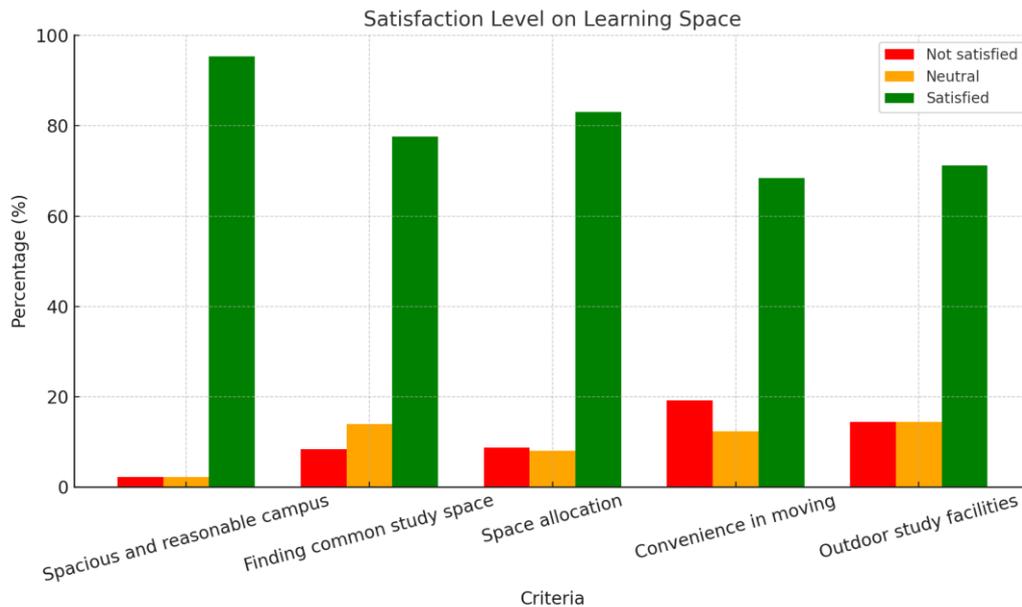


Figure 2. Student and faculty satisfaction with learning area and campus landscape

The bar chart indicates a generally high level of satisfaction among students and faculty concerning campus learning spaces, as evidenced by the predominance of green bars representing positive responses across most evaluated criteria. Notably, the “Spacious and reasonable campus” criterion yielded an overwhelmingly positive response rate, approaching 100%, which suggests a strong consensus on the adequacy and quality of the overall campus layout. However, the relatively prominent appearance of red (dissatisfied) and orange (neutral) responses in items such as “Convenience in moving” and “Outdoor study facilities” highlights challenges in spatial usability. The color distribution underscores the necessity for targeted improvements in spatial accessibility and the adaptability of learning environments. Such enhancements are essential to optimizing the pedagogical experience and aligning with educational philosophy.

For the library and learning materials system, the level of student and faculty satisfaction with the library and the learning material system is shown in Figure 3, which represents two columns for "Satisfied" (green) and "Dissatisfied" (red) levels in terms of criteria related to academic materials and libraries, making it clear to visualise the differences between assessments.

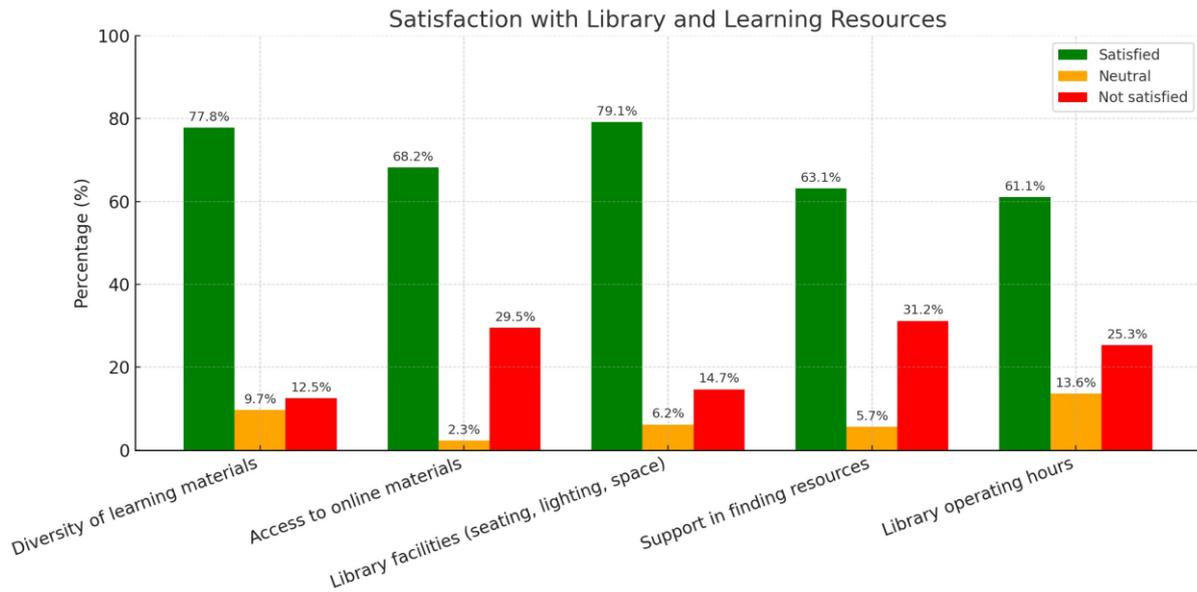


Figure 3. Student and faculty's satisfaction with the library and learning materials

As indicated in the bar chart, satisfaction is the highest for the diversity of learning materials (77.8%) and library facilities (79.1%) with minimal dissatisfaction. In contrast, respondents showed lower levels of satisfaction for “support in finding resources” (63.1%) and “library operating hours” (61.1%). The dissatisfaction rates of these two services are higher than other aspects, accounting for 31.2% and 25.3%, respectively. Digital materials accessibility is also a concern, where the dissatisfaction rate accounts for 29.5%.

With reference to practice and laboratory spaces, the levels of satisfaction of students and lecturers are quite high as indicated in Figure 4 below:

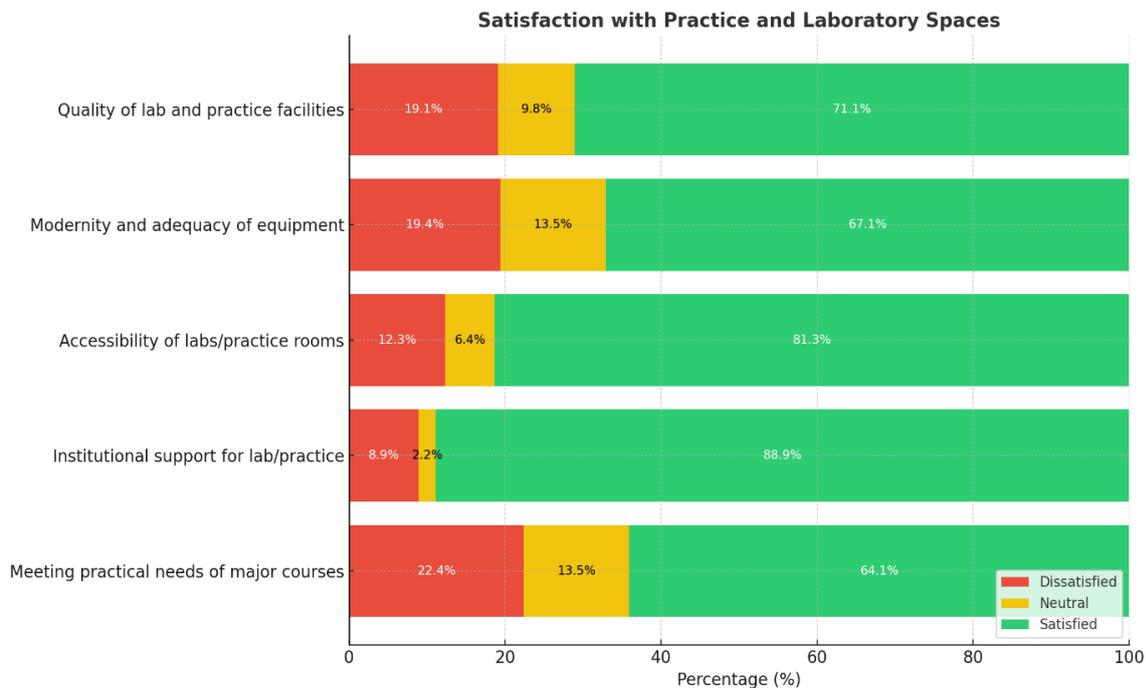


Figure 4. Students and faculty's satisfaction with practice and laboratory spaces

The chart shows a generally high level of satisfaction regarding access to practice and laboratory spaces, particularly in criteria such as “institutional support for lab activities” (88.9%) and “access to labs/practice rooms when needed” (81.3%), as reflected in the dominance of green bars. However, other criteria such as “modernity and adequacy of equipment” (67.1%) and “meeting practical needs of major courses” (64.1%) received slightly lower satisfaction rates and a more noticeable portion of neutral and dissatisfied responses. This indicates that while the overall infrastructure supports hands-on learning, certain departments or specialized fields may still face challenges related to equipment quality and resource availability. These gaps highlight the importance of further investment in both physical and virtual lab environments to enhance practical learning experiences, particularly in technology- and engineering-intensive disciplines.

For learning space integrated with digital technology, the level of satisfaction of students and lecturers with the digital technology-integrated learning space is shown in Figure 5. The different colours represent the three levels of satisfaction: "Not Satisfied", "Not Very Sure", and "Satisfied", helping to visualise the distribution of the percentages of each criterion as a whole.

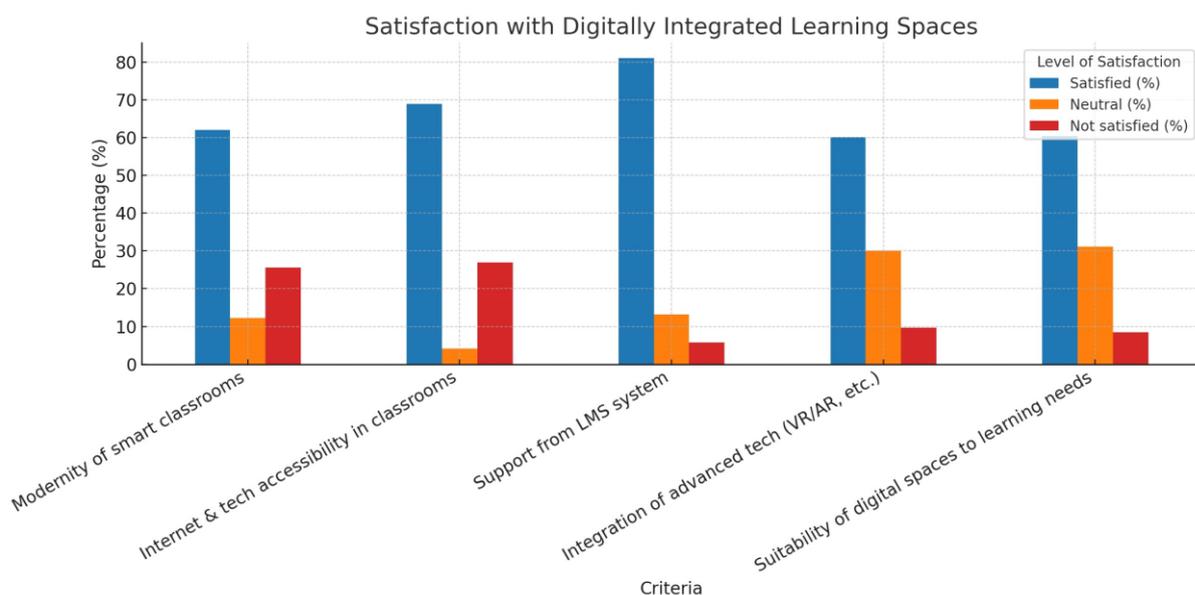


Figure 5. Satisfaction of students and lecturers with digital learning spaces

The survey results on the satisfaction of students and lecturers with the digital technology-integrated learning space reflect the institution’s efforts in digital transformation, and also point out the limitations that need to be overcome. The modernity and comfort of smart classrooms reached a satisfaction level of 62.1%. However, there were still 25.6% dissatisfaction, indicating the need to invest more in facilities. The ability to connect to the internet and use technology in classrooms received 68.9% satisfaction and 27% dissatisfaction, showing that the internet and technology accessibility in some areas of the university needs to be improved. It should be noted that online learning management systems (LMS) gained the highest ratings, with 81.1% satisfied and only 5.7% dissatisfied, reflecting the effectiveness of learning and teaching support. Nonetheless, integrating modern technologies such as VR/AR and specialised software in teaching received only 60.2% satisfaction, 9.7% dissatisfaction and 30.1% neutral opinion, revealing that the university needs to increase the application of advanced technologies to improve the teaching experience. The suitability of the digital

learning spaces with learning needs gained 60.4% satisfaction while the dissatisfaction rate was 8.5%, and the neutral responses accounted for 31.1%, which set the adjustment requirement so that the digital learning space is more closely associated with the actual needs of students and lecturers. In short, although the university's digital technology system has notable strengths, such as the effectiveness of LMS, there are still limitations in infrastructure and integration of modern technology. Improvement of these factors will help enhance the student experience and more comprehensively promote digital transformation in education.

In addition to the survey results mentioned above, the in-depth interviews with 20 lecturers and students provided further information about the university's digital learning resources and spaces. Most of the interviewees commented that although the university campus is spacious, it has not been optimally designed to serve students' experiential learning activities. Common learning spaces for students, such as self-study areas or group discussions are insufficient for students's demands, especially at peak hours and at the end of semesters when they intensively prepare for their final exams and assignments. Access to digital resources on the LMS is generally readily available; however, it is sometimes hard for students to download online materials when they study at campus 2, where the internet connectivity is not as strong as it is at the main campus. The e-lectures serve as pre-class resources which students have to work on before face-to-face interaction in the classroom; the accompanied tasks and activities have not met students' expectations. In e-lectures, each chapter is usually followed by a multiple-choice test and students are expected to achieved at least 70% correct answers to make sure that they have grasped the lesson contents. Our interviews indicated that the students expect to be guided by a virtual teacher (AI assistance) when they are unable to fulfill the end-of-chapter tasks. Interviews with faculty reveal that a majority of them need training in AI application for developing digital materials. The faculty also stressed the importance of upgrading the university's digital learning spaces as specified in Standard 6 of the CDIO version 3.0.

Thus, the results of the in-depth interviews with faculty and students concur with the previously collected survey data. The qualitative responses reflected the same key issues identified in the quantitative analysis, including the lack of optimized spatial planning, limitations in laboratory equipment, and the urgent need to invest in digital learning resources and technology-integrated spaces. Positive assessments of the library and the LMS system were also reaffirmed, highlighting existing strengths that should be further promoted. This consistency between qualitative and quantitative data provides an overall picture of the current state of learning spaces at the university, based on which some suggestions for improvements are made in the following section.

### *Benchmarking against CDIO Standard 6*

Standard 6 of CDIO 3.0 defines engineering learning workspaces as a physical learning environment that includes engineering workspaces and laboratories that support and encourage hands-on learning of product, process, system, and service building, disciplinary knowledge, and social learning, combined with a digital learning environment that includes on-line tools and spaces that support and enhance the quality of teaching and student learning. There are six levels of achievement (0-5) indicated in Table 2 below.

Table 2. CDIO Standard 6 rubrics for self-assessment (<https://cdio.org/content/cdio-standards-30>)

CDIO Level	Criteria Description	Self-assessment
0	Technical learning spaces are insufficient or unsuitable for supporting practical skills, knowledge, and digital social learning.	Not applicable
1	The need for technical learning spaces to support digital, practical, and knowledge-based activities has been recognised, and a process to address this need has been initiated.	Achieved
2	Internal groups, including stakeholders, evaluate workspaces' functionality and teaching purpose.	Achieved
3	Plans for developing technical learning spaces are being implemented, and some new or renovated spaces are being utilised.	Achieved
4	Technical learning spaces fully support all digital, practical, knowledge, and skill learning components.	Achieved
5	Evaluation groups regularly review the impact and effectiveness of workspaces on learning and make recommendations for improvements.	Not achieved

The results of the survey and interviews indicate that Vinh university has significantly invested in renovating and developing technical learning spaces to meet the teaching and learning needs. The university's learning spaces such as laboratories, practice facilities, and virtual spaces have quite well support the students' development of knowledge and skills. Benchmarked against the rubrics in Table 3 above, the university has met the basic requirements of level 4 when the learning spaces have been able to comprehensively support technical training activities. Nonetheless, there are certain aspects that need improving.

## DISCUSSION AND CONCLUSIONS

### *Discussion*

The survey and interviews show that the learning spaces at Vinh University have been positively evaluated in many aspects, in which the digitally integrated space is a highlight of the university's blended learning model. The university requires that the teaching process be divided into three phases: pre-class, during class, and post-class. In the pre-class phase, students learn on the LMS, which provides them with e-lectures, related activities and assessment. The expected learning outcomes of this stage are level 1 and 2 of the Bloom scale, which means remembering and understanding. The second phase is devoted to face-to-face interaction with lecturers and peers. The expected learning outcomes for this stage are levels 3 and 4 of Bloom's taxonomy, which corresponds to application and analysis. In the post-class stage, students review the lessons, do practice and perform experiments or implement their projects. The expected learning outcomes of this phase can be at levels 3, 4, and 5 (creating). The study indicated that the e-learning system with video taped lectures and

corresponding online activities has significantly facilitated students' active learning and self-study before face-to-face classes. Thanks to their prior self-study with LMS, students have more time for in-person group work, discussion, and practice in class.

The findings, however, also reveal that there is some room for improvement in planning, facilities and digital technology integration. Synchronous solutions are needed to meet students and lecturers' expectations. First, integrating modern technologies such as VR/AR and simulation software into the practice space will enhance the learning experience. This helps students gain a deeper understanding of the concepts and better prepares them for the requirements of the modern labour market. Second, developing digital learning spaces to support digital transformation in learning with priority on enhancing high-speed internet connectivity and deploying smart learning devices. In addition, the university needs to expand the application of advanced technologies such as VR/AR, simulation systems and interactive tools. These technologies provide an enriching learning experience and help align the teaching content with the actual needs of students. AI application to develop e-lectures should also be encouraged to facilitate students' pre-class learning activities. Technically, online learning management systems (LMS) must also be upgraded to support the personalisation of learning pathways and enhance interaction between faculty and students. This will create a more flexible and effective learning environment. Finally, it is necessary to develop an integrated learning space with physical and digital components that maximise students' potentials and support the blended learning model.

### **Conclusions**

The paper analysed the current status of the learning spaces at Vinh University based on the CDIO model in the context of digital transformation. The research points out strengths and identifies limitations of CDIO-based application at the institution, thereby proposing specific solutions to optimise the design and development of learning spaces. The findings indicate that the application of the CDIO model with digital learning space design has been proven to be appropriate and effective in integrating technical, practical and innovative elements into the training process. At the same time, digital transformation has facilitated the application of advanced technologies such as VR/AR, online learning systems (LMS), and digital materials, opening up opportunities to enhance the learning and teaching experience. The research findings also imply that it is essential to improve not only the digital learning spaces, but also the quality of digital learning resources to enhance students' CDIO experiences.

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