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Adapting design of Learning Spaces for Education 4.0: a case of architectural institutions in India

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Abstract

A new generation of higher education institutions need spaces designed to support interaction, collaboration, flexibility, social engagement, and the use of technology to make the youth competent for Industry 4.0. The learning spaces of Education 4.0 in Architecture colleges are unexplored; whether they also need the same type of spaces as other higher education institutes for 21st century pedagogy, is yet to be determined. The aim of this research is to find out the change required in formal and informal learning spaces in architecture colleges with the new trend of learning and skills required in Architecture Education. The research methodology adopted here is the case study research approach, together with the tools of survey and interview. A comparative analysis of the learning spaces in four architectural institutions in north India is done on the basis of flexibility, integration of technology and interactive social spaces. A further survey of 150 students and 75 teachers, were conducted to understand the preference of types of learning spaces of the users. The conclusion specifies that there is an equal need for both formal and informal learning spaces to enhance the learning of the students, and changes are required in the formal and informal learning spaces to incorporate these three factors of flexibility, integration of technology, and interactive social spaces for empowering youth with skills for fourth Industrial Revolution. This research will assist architects in creating a better learning environment for the Education 4.0 and future architects.

KEYWORDS: Learning Spaces, Architecture Colleges, Innovative Learning Environments, Education 4.0.

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1. Introduction

Educational spaces have recently regained importance in the ever-changing trend of learning. The stakeholders of these spaces want to revitalise the campus's formal and informal learning spaces to provide quality education. Quality education requires the development of competency-based skill in youth to meet the needs of the industry 4.0, the Fourth Industrial Revolution (Islam, 2022). Learner-centred approach is required for empowering youth with competency-based skills. So, the learning-teaching process has a shift from teacher-centred to learner-centred, but still the educational space has not been modified from "instruction space' to a "learning space". Now the future of learning is not restricted to the classrooms alone, but the informal spaces have also gained the importance in this next generation Education 4.0 era.

Pedagogy, space, and technology are interrelated, as defined by Radcliffe (2009) in the PST (Pedagogy, Space, and Technology) framework. Technology can support learning spaces and enhance learning. Moreover, it is important to incorporate technology as the students should be competent in using technology for fulfilling the needs of Industry 4.0. Technology also stimulate curiosity and inspire students' desire to learn. Provision of technology will help the students get information at their fingertips. Now the need of 21st century learner centred learning is to bring together formal and informal activities in an environment that supports learning at any place and any time. Instead of replacing the traditional classroom, the goal is to rethink

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it and incorporate it with other learning settings to create a setting that is more focused on the needs of the learners.

Learning spaces can be categorized as informal, formal or virtual learning spaces. Informal learning spaces provide places for collaboration and study to occur before or after class. These spaces include libraries, public or gathering spaces, quiet and breakout areas, interactive spaces, physical education areas, nature walks/ pathways, green areas, and corridors/transition spaces created within corridors. Formal learning spaces are learning spaces used for regularly scheduled classes. These spaces are identified as traditional classrooms, lecture halls, technology-infused classrooms, design studios, workshops, computer labs, laboratories, and active learning classrooms. Web-based environments or platforms for learning are used in virtual learning spaces, which are typically found in educational institutions.

In Architecture education, creativity and long hours of dedicated work is very important so institutes need learning spaces that can foster creativity, provide flexibility, collaboration and integration, and support the students to enjoy and do work without stress. Architecture education deals with the learning of the built environment but the students are not provided with the learning environment required to fit well in their learning. New forms of collaborative and interacted learning spaces must not only be integrated into formal learning, but must also be in design adapted for different spaces present in the campus. Although our understanding of learning and the conditions under which it is facilitated have substantially improved; the majority of Architecture colleges have classrooms as well as the design studio, which is the core of Architecture Education, remained in a rather traditional form. Further, another challenge is the integration of technology in the teaching-learning process to provide technology-enhanced environment. Moreover, the Architecture is moving towards Digital Architecture. Now it's a challenge to bring together space, technology and learning to develop learning environment for the students that suits well to new trend of learning.

2. Defining learning spaces

2.1 Learning spaces

Learning spaces are places where learning occurs either in physical or virtual mode (Macphee, 2009). The term is used mostly in classrooms, but it actually refers to an indoor or outdoor location, which can be either actual or virtual. Though classrooms and laboratories are known to most people, auditoriums, performance rooms, computer labs, and studios are also important formal learning spaces (Lomas, 2005). In educational institutions, learning rooms are used in a wide range of ways and have a wide range of configurations and locations. These settings support a range of pedagogies, such as silent, cooperative, or active learning, virtual or real-world learning, vocational, experiential, and hands-on learning, among others (Wikipedia). A learning space should be able to motivate learners, promote learning, support collaborative and individual learning, provide a personalised and inclusive environment, and be flexible to adapt to the changing needs of the students (JISC, 2006). Malcolm Brown states in the research paper titled 'Educating the Net Gen' that the Net Generation students use a variety of digital devices and turn every space into an informal learning space outside the classroom.

2.2 Importance of learning spaces in learning

Deeper and richer learning can be encouraged when the spaces are designed with learning in mind. Educators must create structures that support this learning. Space strongly influences learning, and the type of space designed determines the type of learning that is going to occur in that space (Chism, 2006). The physical learning environment supports formal teaching and informal learning as well as individual and social learning when designed with proper considerations. They were all interactive and totally supportive of one another (Kuuskorpi & Cabellos, 2011). Researchers (Obeidat & Share, 2012) highlighted the need to design the learning space or environment according to the needs of the students and teachers, such as a design studio where students and teachers spend the maximum time in architecture education and require an environment that is suitable to their needs. Intentionally created spaces are harmonious with learning theory and the needs of current students, moreover it reflect several elements such as: flexibility, comfort, sensory stimulation, technology support, collaboration, and socialism (Chism, 2006). The transformation of learning spaces into creative spaces is a great challenge and depends on our understanding of how students learn (Dittoe, 2006). Space can have a significant impact on teaching and learning. Exactly how space, technology, and learning are brought together will continue to evolve (Oblinger, 2006).

2.3 Impact of student's habits & culture on learning spaces

Another researcher stated that learning environments on campus can have a significant impact on students' lifestyles and cultures (Obeidat & Share, 2012). Architecture education is a 24-hour learning process. If a suitable environment is not provided to them, then they will lack interest and dedication towards their work. According to researchers Lomas and Oblinger, well-designed learning environments made possible by technology inspire students to spend more time on campus, become more engaged, and improve retention. Discussions about learning spaces are aided by knowledge of students' characteristics and routines. As they read, take notes, write, chat, or simply enjoy

campus life, students relax alone or in small groups. They are also seen to be involved in using mobile phones, iPods, personal digital assistants (PDAs), and laptops (Lomas & Oblinger, 2006). Learning spaces promote learners to work on group projects, interact in collaborative or cooperative learning, showcase their work publicly and guide others (Lomas, 2005). 21st century learners organise their own schedules, as well as track and assess their own learning (Shaw, 2017). So learning spaces should be designed to shape and support learners' needs, habits, and culture.

2.4 Various learning settings in educational institutions

Kenn Fisher (2004), in his research 'linking pedagogy and space', has explained various spatial settings that are required for different pedagogic activities. He brings out five main pedagogical activities as delivering, applying, creating, communicating, and decision making; which require various learning settings such as individual, group, activity-rich, informal learning, and staff settings (Department of Education and Training, 2004). Each learning setting is supported by different spatial settings. Similarly, the researchers (Baburaj & Mukherjee, 2011) also identified various learning settings as group learning settings, simulated environments, peer-to-peer learning settings, individual learning settings, social learning settings, and multi-purpose learning settings, for which different learning spaces need to be designed. The study of various researches gives an idea of the various learning settings that need to be taken care of while designing spaces for any educational institute. Learning spaces must incorporate spaces for all the learning settings.

2.5 Learning spaces in architectural institutions

Historical context: Until the mid-nineteenth century, architectural education was based on an apprentice system where young architects served under the mastery of an accomplished architect, as in the Ecole des Beaux-Arts located in Paris. The Beaux Arts period in Paris had four primary elements: the Ecole, private ateliers, the Salon, and café life. The Ecole was the traditional study of classical painting and architecture, associated with the Grand Prix de Rome, a competition in which the winner would get a full scholarship to study in Rome. In the small independent ateliers, students learned directly under a "master," with all the success of the students reflected directly back on the master. The annual Paris Salon was the show in which the best works, as chosen by a jury, were displayed to the public. Lastly, café life was the informal extension of the ateliers and the Ecole, where people came together to discuss design (Woznaik, 2016). The ateliers brought a new approach to architectural design education, which can be described as "learning by doing" in a design studio. Since then, the design studio has been the core of education in the field of architecture. Design knowledge, thinking and understanding are created in the design studio through projects, charettes, discussions, workshops and other activities (Pak &Verbeke, 2012).

In the 1920s, with the influence of the modernist movement, architectural education was reformed to fit the needs of the emerging socio-economical context. At the heart of the modernist movement, the German Bauhaus School led this transformation and integration of new concepts related to mass production and new technologies. This reform has had a significant and global impact on the schools of architecture, especially during and after the Second World War. Although the Bauhaus ideas have transformed architectural education, the studio-based learning model has remained mostly unchanged (Pak &Verbeke, 2012). One of the great insights of the Bauhaus movement is to recognise that creative education is about more than passing on and refining technical knowledge or skills. The Bauhaus School's learning culture encouraged experimentation at a fundamental level by encouraging students to produce their own creative designs based on their own subjective perceptions. Even parties and stage performances were part of the curriculum, with students encouraged to experiment in costume and stagecraft. The parties promoted contact between the college and the public. There was also the fact that they lived and ate together, with recreational activities and sports, for which the Bauhaus building in Dessau provided many opportunities (Life at Bauhaus).

Contemporary learning spaces: Contemporary architecture schools maintain many of the core ideas of the Beaux Arts method: the creation of competition and intensity between students; the strict hierarchy of students and teachers; and the jury or professor's power to decide upon the "correct" and best student work' (Woznaik, 2016). 'Despite huge changes in lifestyle and technology, no significant differences can be found in traditional and contemporary classrooms. The standard layout in schools, which consists of pupils sitting at perfectly aligned desks for the majority of the day and a teacher standing in front of the classroom to deliver the lecture, may be more streamlined desks and/or feature an interactive whiteboard mentions (Wierman, 2016). In the present situation, the design studio still plays a central role in architectural education. Studio work is individually mentored by the course instructor and reviews are given. Active participation in group discussions and constructive class critiques is encouraged by the instructor. ' The findings of this study indicated that a student's way of working in the architectural design studio was tied back to several factors, including the influence of their course instructor (Salama, 1995), the student's learning style, the student's interests, and the type of environment of the studio (Lueth, 2008).

The researchers (Pak &Verbeke, 2012) stated that e-learning supports the whole learning process in the design studio, but the balance between e-learning and

face-to-face learning is important for the success of the e-learning practices.

On the campus, the architecture students move between multiple locations during the concept development stage, where their architectural vision develops. These spaces include libraries, on-campus and off-campus social areas, and open spaces. When it comes to design development, the studio is preferred, where formal discussion and team work are done. The research further concluded that students prefer a space where different activities can be carried out alternately. An open space adjacent to the library is frequently used by students in comparison to the interior of the library. So, design studios designed adjacent to outdoor spaces function as generic spaces (Abdullah et al., 2011).

Today, schools have lost their informal café aspect as well as the spirit of discussing designs in an informal setting. 'If we dismantle the rigid hierarchy and need for competition and recreate the informal café style of architectural discussion and innovation in contemporary architecture schools, then they would become better environments for learning and designing' (Woznaik, 2016).

2.6 Approaches to learning spaces for 21st century

21st century learning spaces support multidisciplinary, team-taught, interactive learning, not restricted by conventional class period-based constraints, within a setting that supports social interaction and fosters student and instructor engagement (Pearlman, n.d). Classroom design for the 21st century aims to create an environment that fosters students' personal growth in communication, collaboration, creativity, and leadership skills (Wierman, 2016). The report "Designing spaces for effective learning: guide for the 21st century learning design" defines the 21st century learning space as being able to motivate learners and promote learning as an activity; support collaborative as well as formal practice; provide a personalized and inclusive environment; and be flexible in the face of changing needs. Flexible, future-proofed, bold, supportive, and creative learning spaces should be designed (JISC, 2006).

The researcher (Oblinger, 2005) supports a more focused and learner-centered approach to the 21st century learning spaces. According to (Broodryk, 2015), flexibility, openness, and access to resources are the most important features to be considered for modern learning environments. Furthermore, the researchers (Baburaj & Mukherjee, 2011) also bring out the learning environment design features such as flexibility & comfort, technology, and spaces for social and collaborative learning. The design of learning spaces for a student-centered approach should follow the principles of multiple use, flexibility, use of vertical dimension, integrate campus functions, maximize teacher and student control, maximize alignment of different curricula activities, student access to, and use and ownership of, the learning environment (Jamieson et al., 2000). Brown and Long (2006) suggest three main principles to facilitate learning space design. First, it should be focused on the learning experience and pedagogical theories, and then on how students learn individually and in groups. Second, there should be an increase in the ownership of technological devices that enrich learning. Thirdly, the design process should be influenced by human-centered concerns and integrate resources that support learning rather than be just accessible. Through various researches related to 21st century learning, it has been derived that the main features that are required for active, social, and collaborative learning in the 21st century are flexibility, integration of technology, and interactive and collaborative social spaces.

Flexibility: Flexibility can have multiple meanings (Head, 2016). Flexible learning spaces are ready for today and future-proofed for any changes to teaching and learning in the years to come. Flexible learning spaces consist of multiple spaces for many types of individual and group-based teaching and learning practices. These spaces also enhance and enable innovative learning environments, where student-centred learning and collaborative teaching practices are at the core of a school's educational vision. Flexibility is provided in all the spaces, whether they are indoor spaces, outdoor spaces, access & circulation, or storage (Evaluation and Education Policy Analysis, 2015). A related concept is "versatility," which one architect defined as a space that motivates users and "inspires different uses," for example, the computer lab that also serves as a maker space (Head, 2016). Flexibility allows multi-functionality within a class session, as it makes it possible to quickly re-organize the available space for a particular activity (s). One recent approach to increasing flexibility has been to divide a total area to allow for specific functions, for example: formal class, group work, computing, etc. (Jamieson, 2000).

Students can come together to discuss, interact, and create in the open, flexible spaces, which supports a 21st-century learning method (Wierman, 2016). In a design studio classroom, flexibility in furniture arrangement is critical; students may need to rearrange their tables in various ways to accommodate self-study and cooperative projects; as well as additional levels of interaction (Obeidat & Share, 2012). The layout of the room and the furniture used can have a big impact on how well students learn (JISC, 2006). Flexible spaces in learning centers, on the other hand, engage learners in a continuous flow of learning and allow for tutor-to-learner support sessions and group assignments to be initiated (Painter et al., 2012).

Integration of technology: Modern classroom design places a strong emphasis on technology integration. Teachers and students, however, are taking advantage of 21st-century classroom design that applies technology in novel and distinctive ways. Technology is a tool used in these classrooms to generate the interest of students and

to motivate them to learn constructively (Bhandari et al., 2020). Technology, including computers, tablets, and mobile devices, puts knowledge at students' fingertips and inspires them to conduct study and come up with discoveries (Wierman, 2016). The findings of other research suggest that technology can help in promoting more interactive and engaging teaching learning experiences (Anireddy et al., 2022; Casanova & Mitchell, 2017). It has altered learning spaces by stimulating more interaction through the use of personal response systems or by videoconferencing with international experts (Oblinger, 2006).

In many simulation environments, video cameras are also a teaching aid, used to record performances in tasks, so that techniques and skills can be improved (JISC, 2006). A wall-mounted camera records key demonstrations, which can be used for distribution to learners from remote areas, or for revision purposes and help in progress. Mobile devices such as laptops and PDAs also encourage learners to access resources available at the institution's network and the internet, and write up their observations as they progress (JISC, 2006). The way that learning environments are used and set up is changing as a result of mobile and personal technologies. It makes learning possible practically everywhere, including research, collaboration, producing, writing, production, and presenting. It encourages teachers and students to personalise learning environments, creating a sense of ownership and relevance (Zandvliet, 2017).

Interactive social spaces: Interactive social spaces are mixed-use spaces where conversation, collaboration, and informal learning are encouraged, facilitated, and expected. A social space is also intended to support academic and leisure activities and events, and cafes/coffee bars, maker spaces, and art galleries' (Head, 2016).

Well-designed social spaces are likely to increase students' motivation and may even have an impact on their ability to learn. Often large underutilized spaces already exist in most of the Colleges and the Universities. If common rooms, even corridor space, were reconsidered as social meeting and group learning environments, institutions could both save on large-space provision and make a statement about their vision for learning as a pervasive and inclusive activity based on social interaction (JISC,2006).

Social spaces need not make distinctions between different types of users. The principle of pervasive, communal learning, which sees both staff and learners as co-users of a space, is potentially achievable through the re-purposing of spaces which are currently allocated separately to staff or students, such as common rooms (Painter et al., 2012).

Emerging designs place emphasis on one high-quality social space as a central focal point in the building, which caters for the needs of all users of the building – visitors, staff, learners and potential learners of all abilities. The area is both a public facility providing meals and refreshments, and a place where learners and staff can meet for short discussions. It is wireless enabled, but it is not set apart from learning—student services may also be located adjacent to this space to take advantage of its widespread use (Hill, 2013).

The development of purpose built informal social learning spaces as a strategy to enhance the student experience is becoming more prevalent, although empirical research in this area is lacking. As a result of encouraging active learning, social contact, and a sense of belonging among tertiary students, the study's findings show that social learning environments can boost student engagement. According to the study, students' impressions of social learning spaces are influenced by design, among other things (Matthews et al., 2011). These informal learning and social spaces are respectful of student cultures (Newton, 2011).

3. Methodology

Case studies of Chandigarh College of Architecture (CCA), Chandigarh; Centre for Environment planning and technology (CEPT), Ahmedabad; Gateway college of Architecture and Design (GCAD), Sonipat, Haryana and Regional institute of management and technology (RIMT), Sirhind, Punjab are taken for study. CCA and CEPT came into existence in the 20th century whereas GCAD and RIMT are 21st century Architectural colleges. A visual analysis was conducted to study the learning spaces in these colleges. This analysis of the spaces is done on the basis of three aspects: flexibility, integration of technology, and social interaction.

A survey is done on teachers and students of these colleges to find out their perception in terms of learning spaces. A sample size of 150 students is used here, with an average of 30 students from each college, and a sample size of 75 is taken for teachers. The survey is conducted with the help of a self designed questionnaire in order to find out the preference of teachers and students towards learning spaces in Colleges. A different set of questions are asked from Teachers and students. Teachers are asked to respond regarding the questions like type of learning spaces preferred in an Architecture College, type of classrooms preferred, type of arrangement and facilities preferred in studio. Further teachers were enquired about type of learning spaces required in Architecture College, type of classrooms for effective learning, studio arrangements, and cafeterias to support teaching learning process and teacher workspace required, etc.

Another survey for students' respondents were surveyed about their perception towards learning spaces in college, facilities preferred in studio, computer aided labs and library spaces for effective learning, informal spaces required to enhance their learning including cafeterias etc.

4. Analysis of data

Visual Analysis of the Architecture Colleges came to the conclusion that Architecture colleges constructed in the late 20th century have a vision for informal learning, as they have more of informal learning spaces than formal learning spaces. Informal spaces like corridors, walkways, and courtyards are distributed all throughout the campus. On the other hand, architecture colleges constructed in the beginning of 21st century have a. linear planning developed with rows of classrooms around the corridors. They gave more emphasis on formal learning environments than on informal ones. Informal spaces like the library and canteen are restricted to the corners, while corridors are just used as a passage. GCAD have a vision for contemporary learning and have informal learning spaces almost equal to their formal learning spaces. Interactive informal spaces are placed in between formal spaces, which have been spread all throughout the building.

The architecture colleges were visually analyzed to understand the uses of formal and informal spaces by the students and teachers to find out the need for various features of flexibility, integration of technology, and social interaction in architecture colleges. Various spaces that have been studied include lecture halls/classrooms, studios, workshops, computer-aided design labs, libraries, cafeterias, corridors/ walkways, break-out spaces, transitional spaces, gathering spaces, think spots, multipurpose spaces, storage spaces, teacher spaces, and outdoor well-defined spaces.

Flexibility is adapted to only a certain extent in RIMT and GCAD. CEPT have incorporated flexibility in the arrangement of furniture, flexibility in the use of learning spaces, and flexibility in working hours. Use of technology is restricted to the use of projection screens and projectors in the colleges considered under study. Only a few colleges with the vision to contemporize learning have used it to a greater extent. Interactive social spaces are very important in architecture education as they develop strong interaction between the students and encourage team work. Most colleges of 21st century are unaware of the importance of these spaces and have not used them wisely for the interaction of students. However, 20th century colleges have successfully created interactive social spaces and integrated them into the learning process. They have also used the courtyard and pathways as effective interactive social spaces.

Figure 1 – CEPT Site plan.

Figure 2 - CCA Floor plan (Yellow, green, orange and cream colour represents various informal areas).

Figure 3 - RIMT Ground Floor plan.

Figure 4 - GCAD Ground Floor plan.

Perception of Students

The analysis of the survey is based on the results of 105 student responses. More than 80% of students believe that both formal and informal learning spaces must be incorporated into colleges. Among the formal spaces, 70% of students prefer flexible and interactive classrooms. Within their studio, they would like to have flexible furniture which they can arrange according to themselves. It should have sufficient space for the movement of teachers and students between the tables and must permit interactive sessions. Around 65% of them believe that separate provision for use of laptops is required and lecture provision is not required within the studio. Around 50% of them think that plug points, projectors, and projection screens must be provided in the formal learning spaces together with Wi-Fi connectivity in the informal learning spaces like learning commons, transitional spaces, and small interactive spaces within the building. More than 65% of students also wish to have break-out interactive spaces to relax within their long design classes. In colleges, most students don't prefer to

Responses of the student survey

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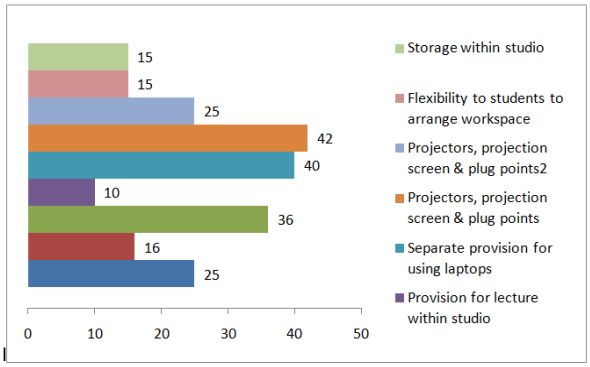

Figure 5 - Preferred Arrangement of studio spaces.

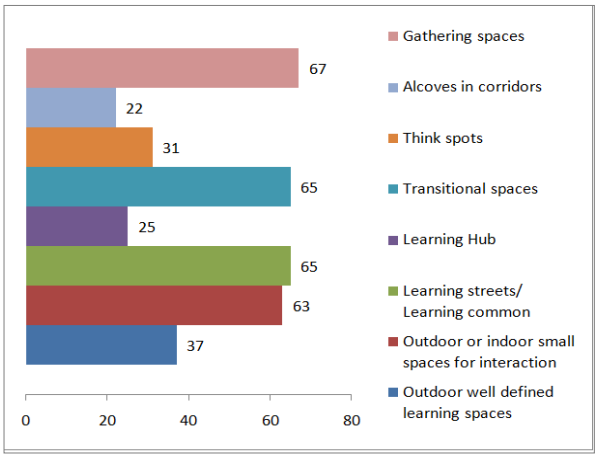

Figure 6 - Preferred Type of Informal spaces.

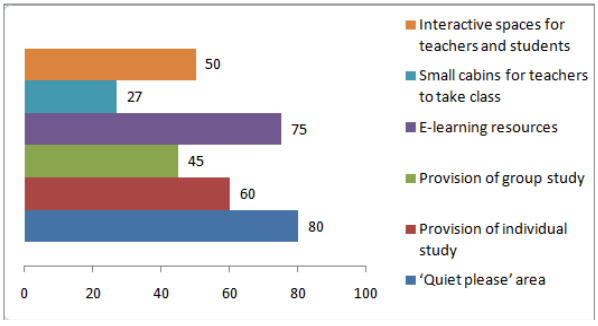

Figure 7 - Preferred Library spaces.

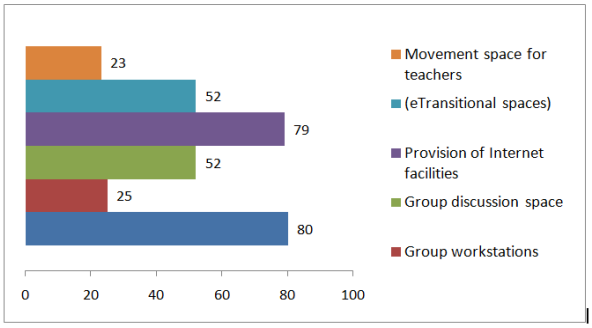

Figure 8 - Preferred Computer lab spaces.

separate individual spaces. Group learning spaces are preferred by only 45% of the students. The provision of small cabins for teaching within the library is not appreciated by most of the students. They think that it would be better to provide interactive spaces for teachers and students within the library. The cafeteria must be away from teaching-learning spaces with a mix of refreshment and Wi-Fi access according to 75% of students. Around 65% wish to have group learning spaces within the cafeteria to promote interaction between students and teachers. They don't prefer individual learning spaces in cafeterias. Around 80% of students want internet facilities in a CAD lab with individual workstations. Group discussion space, together with sufficient space for movement of teachers and students, is required to be provided by 50% of the students.

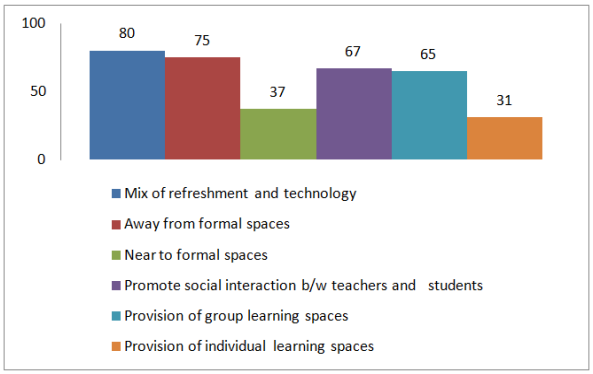

Figure 9 - Preferred Cafeteria spaces.

Flexibility is adapted to only a certain extent in most colleges. Only a few colleges have incorporated flexibility in the arrangement of furniture, flexibility in the use of learning spaces, and flexibility in working hours. Use of technology is restricted to the use of projection screens and projectors in most colleges. Only a few colleges with the vision to contemporize learning have used it to a greater extent. Interactive social spaces are very important in architecture education as they develop strong interaction between the students and encourage team work. Most colleges are unaware of the importance of these spaces and have not used them wisely for the interaction of students. However, some colleges have successfully created interactive social spaces and integrated them into the learning process. They have also used the courtyard and pathways as effective interactive social spaces.

Responses of teachers' survey

The analysis of the survey on teachers is based on the responses of 49 teachers of these architecture colleges. Around 80% of the teachers believe that there must be a mix of formal and informal spaces in a college. Around 60% prefer to have interactive classrooms, while around 50% also wish to have flexible classrooms. None of them preferred to have a traditional classroom. Around 80 % believe that studios must be equipped with projectors, projection screens, and plug points for students, together with separate provision for laptop tables. According to around 50% of the teachers, the space must have flexible furniture together with space for presentation and display. Break out spaces and provision of lectures within the studio is preferred by only 40% of the teachers. Around 50% of the teachers preferred gathering spaces, learning streets/ learning commons, and transitional spaces as informal learning spaces within the architecture college. More than 50% also preferred outdoor and indoor small spaces close to the teaching learning zone and around 25% preferred

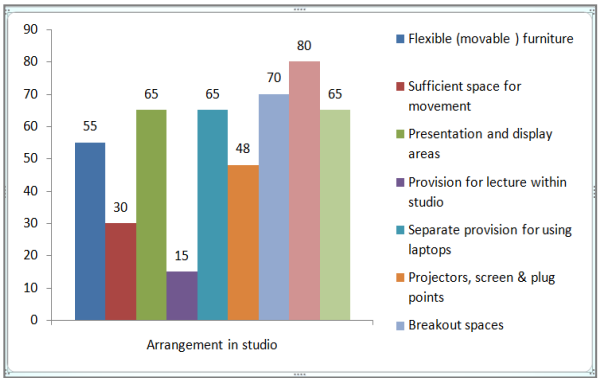

Figure 10 - Preferred Arrangement in Studio spaces.

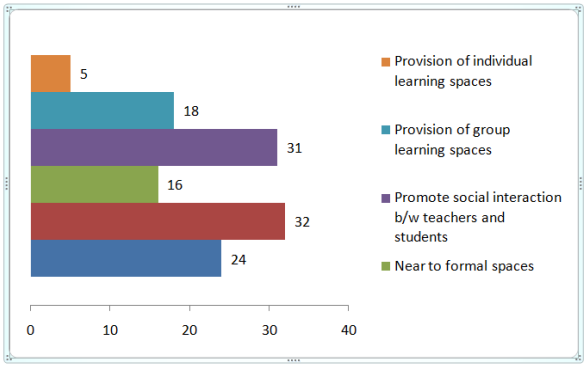

Figure 11 - Preferred Cafeteria spaces.

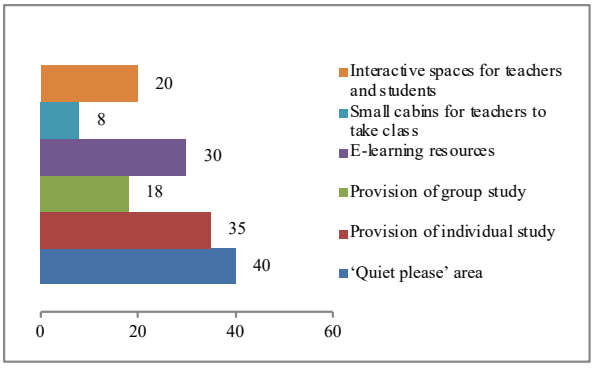

Figure 12 - Preferred Library spaces.

having think spots, while other spaces like alcoves in corridors and learning hubs were not preferred by almost 75% of them. Around 80% of teachers believe the library should be a 'quiet place' with individual learning spaces for the students. The provision of group study and interactive space for teachers and students is preferred by only 40% of the teachers. Around 60% of the teachers believe that e-learning resources must be provided in the library.

60% of teachers agree that cafeterias should be separate from formal spaces and allow students and teachers to interact. 50% of them think that a cafeteria must have a mix of refreshment with technology together with group learning spaces. Around 60% of the teachers prefer teaching in clusters, 25% prefer separate classrooms, while the rest don't have any choice. 90% of the teachers wish to have individual faculty cabins instead of a common area for all the teachers. All of them prefer an interactive space for teachers.

5. Conclusion

According to the findings of the study, these three features of 21st century learning spaces, flexibility, integration of technology, and interactive social spaces, are neglected in most of the colleges of 21st century architectural institutions while they exist to varying degrees in 20th century architectural institutions in India. Changes are required in learning spaces to accommodate these factors of flexibility, technology, and interactive spaces in various formal and informal learning spaces.

Flexibility can be a hindrance to the discipline of the institutions. So, flexibility must be provided, keeping in mind the stage of study of the students. Flexible learning methods in classrooms according to the needs and requirements of the topic can be provided with flexible furniture which can be rearranged for individual and group learning. Flexibility of space in classrooms can also be provided through the provision of break-out spaces. Outdoor teaching spaces as well as indoor learning commons should be created to allow teachers to extend their classes even to these spaces and connectivity must be provided between outdoor and indoor spaces. Multipurpose space should be provided as it promotes flexibility of using the space. Workshops must be extended to outdoor spaces also. A computer lab must have both individual and group learning spaces. The library should be divided into various sections like reading, study, and group discussion, to provide flexibility to use the space for various purposes according to the needs of the students.

The 21st century generation is much more comfortable with technology than the 20th century generations. Wi-Fi connectivity should be provided in all colleges to meet the needs of 21st century learning. E-learning resources must be provided in the libraries. Provision of technology-enhanced environments is a must in both formal and informal spaces for teaching as well as learning purposes. Interactive social spaces must be provided at places that can be easily monitored or that are within the visibility of the administrative authorities or the teachers. Interactive social spaces must not include any hidden areas. Interactive spaces must be provided in indoors as well as outdoors. Interaction among the students within the classes is as important as outside the classes.

Further recommendations are given to study the learning spaces with a greater sample size. The study is restricted to some architectural institutions in north India and further study is required on learning spaces in architectural institutions all throughout India to generalize the findings.

Statements and Declarations

We confirm that this work is original and has not been published elsewhere, nor is it currently under consideration for publication elsewhere.

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