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Review and Restructuring of Contemporary Practices in Architecture Design Studio Education

PARVEEN KUMAR

Associate Professor, Department of Architecture, Deenbandhu Chottu Ram University of Science and Technology, Murthal, Sonipat – 131039, Haryana (India)

E-mail: gargarch28@gmail. com.

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Abstract: The paper is based on the premise that a 360 ° restructuring of the existing architecture education system is required to bridge the wide gap between academia and the practical world and equip students to meet national and global challenges. The current field practices are driven by competitive markets and innovations designed to upgrade obsolescent of technologies. Architecture schools act as living laboratories for envisaging the roadmap to resolve issues at the community, city, national and transnational levels. They should act as *avantgarde* for innovative practices by students, disseminating knowledge and pushing boundaries for experimentation -- all as part of a process for boosting development and inclusive growth. A smart education system can be achieved by integrating Information and Communication Technology (ICT) and provide an interface between students and industry. The paper focuses on identifying challenges and barriers in the existing education system and suggests recommendations for improving the quality of human resource. Its purpose includes delivery of high performance and healthy growth of stakeholders. By exploring information and technology, transparency and participatory role of various actors for networking, team building, monitoring and reflective tools, the paper examines the contextual relevance of the existing approaches to various aspects of learning, teaching and evaluation systems, going on to suggest a paradigm shift in these.

Keywords: Innovative Practices; Design Studio Communication; Design Studio Evaluation as Driver; Four-dimensional Learning; Smart Technology.

1. BACKGROUND

Technical institutes in India are mushrooming and hoards of architecture graduates are churned out every year at a high pace. Added to this is the fact that our nation is yet to be developed significantly, with possibilities of even higher investments in infrastructure that would unlock unprecedented opportunities of growth. In view of this, the gaps between "Education" & "Expectation of Profession" need a major review, particularly with dynamics of time and e-highways preparing the "Architectural Professionals of Tomorrow"[1].

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In addition to the use of cutting-edge technology and fierce competition to outperform each other, architecture practices are also facing challenges from internet explosion, increased level of awareness of clients, advent of international firms in real estate, green building certification, etc. Due to the shortage of well-trained faculty in the ever-growing education industry and lack of training opportunities in good offices, the quality of the young architects being produced in most schools is abysmally low. Wide gaps remain to be bridged to achieve and maintain desired performance levels. It is high time that our education system should introspect on its existing curricula and method of teaching, gear up for becoming 'Agents of Change' and, develop visions and missions that can produce 'Enabled Architects' (Kumar, 2015).

2. PROBLEM STATEMENT

Emerging concepts in architecture practice, such as Bio-climatic Architecture and Certified Star-rated Buildings, need disciplined parametric approaches. We also need to develop critical thinking that looks at design as a process designed to meet specified objectives (Barry, 2014). The new role of architects in this complex scenario is to collaborate with a pool of experts drawn from various fields. An 'Integrated Design Studio' approach should now replace the conventional role of the architect as star leader. It also needs to be recognised that in order to optimise resources for sustainable approaches, Information and Communication Technology (ICT) is increasingly being applied as a key factor in designing, space optimisation and, enhancing building performance (Fathi, 2014). The multitude of stakeholders have differing goals and varying expectations from architecture education and training. Without a good education, students have little hope of participating fully in the economic and civic life of the emerging knowledge-based and globally-competitive society.

Keeping in view the vast changes required in architecture education, the author decided to delve into how students understand the system. Learning in architecture is largely based on Studio-learning Practices (Sidawi, 2014). It is through their performance in the Architecture Design Studio that students express their own personality, all their skills and knowledge and rate themselves. Owing to student's role as innovators and creators in studios, that architecture schools serve as living laboratories of design ideation.

But, it is seen that although all budding architects spend nearly the same time in the school, many are not able to perform up to desired level due to a dismal understanding of design objectives at the conceptual level, a poor

[1] Nearly 25000 architects are being added every year and rate of growth of architectural schools is accelerated to double up by next decade. (IIA, 2014)

understanding of contextual issues, poor design communication between them and studio coordinators, poor understanding of research in design, lack of innovative practices by studio coordinators in motivating students and developing their critical thinking, and, lack of objective evaluation (Ostwald and Williams, 2008). The question then arises as to how we can build a "knowledge engine" that would create knowledge assets as well as drive performance (Baird and Henderson, 2007).

Understanding of core issues from the student's perspective will give a fair idea of the existing lacunae in fostering creativity in Studio Learning. This may also provide an answer as to why students are not able to acquire the desired interactive and innovative design skills. This paper discusses the results of a review performed by the author on 'Design Studio Communication and Evaluation' with the objective of critically examining the core issues pertaining to current students of architecture. The objectives of research were:

a. To identify various issues in design studio conductance and communication that affect students' performance and ability to adopt innovative practices;
b. To understand the impact of various design studio parameters deemed significant by the teachers and the innovative practices adopted by them for evaluation of students' designs;
c. To understand the nature and role of various drivers responsible for creating and maintaining high momentum in architectural design studio education.

3. RESEARCH METHODOLOGY AND DATA COLLECTION

The methodology adopted in this study comprises an online survey with the questionnaire being e-mailed to the undergraduate as well as graduate students of the Department of Architecture of Deenbandhu Chhotu Ram University of Science and Technology (DCRUST), Murthal, Sonipat, India. Students of DCRUST's affiliated colleges (which share same curriculum), as well as students of architecture of some other universities also participated. The object was to assess perceptions of students, who were asked to rank their preferences on a 4 or 5 point Likert Scale. The questionnaire itself was developed through literature review as well as discussions with graduate students to understand various core issues using Google docs. As a first step, a pilot questionnaire survey was conducted to understand variance and sample size. The questionnaire was a result of feedback from pilot respondents. The questionnaire was circulated to 400 students of different schools of architecture of which 100 responses were received. Using the probabilistic random sampling method, getting a response rate of 25% can be considered as very good.

The questionnaire was circulated in May 2015, after the end of academic term, so that students could freely express their ideas without fear of possible negative impact on their evaluation. Also, it was felt that better responses could be received after completion of the studio exercise and evaluation by the studio conductor. The questionnaire was mailed to 2nd, 3rd and 4th Year B. Arch. students, leaving out 1st year students (with a very elementary knowledge of design) and, the Final Year students (who are not involved in a regular design studio). But, they were interviewed to assess depth of issues.

The questionnaire comprised six sections. Section 1 contained 5 questions on the background of the students. Section 2 had 6 questions on various aspects of 'Design Problem Statement' (such as use of brainstorming, literature review, case studies and site visits for pre-design stages). Section 3 sought responses on 'Design Studio Conductance' (source of information, knowledge base, hands-on experience, innovative practices and creative thinking, time allotted, etc.). Section 4 concerned 'Design Studio Communication' (conflict management, quality of discussions between student and teachers, use of social media network, "*Connect"* between student and teacher, students' level of satisfaction for constructive dialogue and, interdisciplinary approaches to design). Section 5 had 13 questions on design evaluation, marking criteria and various thrust areas of significance considered by evaluators (listed 52 variables). Section 6 was of 4 questions on 'Design Studio Infrastructure and Resources.' The concluding part asked for open-ended suggestions for improvement. Each respondent took around 10-12 minutes to complete the questionnaire on their mobile phones or laptops.

4. DATA ANALYSIS

4.1 Respondents' Background

58 % of the respondent students were from Deenbandhu Chhotu Ram University of Science and Technology (DCRUST), and 42 % from other colleges. Thus, the survey represents generic observations of students of institutions following same academic calendar and curriculum [2]. Students of 3rd and 4th Year B.Arch. constituted 48% of respondents; whereas 34% of respondents were of 2nd Year B.Arch. 18% of the respondents were students of the graduate programs of DCRUST, but had completed their undergraduate studies from different universities.[3] The Studios were conducted by experts drawn from an array of different expertise.[4] The minimum and maximum SGPA (scale of 10) scored by respondent students was 5.04 and 9.27, and the mean was 7.48, with 0.972 as standard Deviation. It is clear from the profile of the respondents that they represent a fairly good cross-section of academic abilities (Table 1).

Table 1: Academic Record of Respondent Students.

Parameter	Mean	Minimum	Maximum	Standard Deviation
SGPA (Scale of 10)	7.48	5.04	9.27	0.972

4.2 Design Problem Statement

A well laid out design problem, along with clearly earmarked objectives and intent, can pave the way towards potentially better design solutions. This section addresses questions related to Pre-design Studies as well as how effectively a design problem is stated. 54% Students responded that the design problem was well stated and articulated, while 76% respondents affirmed that the Literature Review conducted in the studio was adequate. Results of this survey are depicted in Table 2. However, in general practice, a State-of-the-Art Literature Review is not conducted at the undergraduate level in architecture schools.

Although, as per the survey, the design problem issued to students is well stated, but 77 % of respondents confirmed that it is only on rare occasions that students' consent is taken, or brainstorming carried out for the type of project to be undertaken. Another important parameter is the introduction of a real life (and not a hypothetical) project and making sufficient visits to the design site. However, 57% of students stated that this generally does not happen. The quality of site responsiveness in designs cannot be evoked effectively without exposing students to real sites and development conditions.

In architecture, invariably, a 'Case Study Approach' is used by the studio conductor to show a prototype model and a real world picture of space planning and equipment. Case studies also involve analysis of user behaviour and other elements of architectural design by interviews or questionnaires. But, 60% of students responded in negative for guided case studies by faculty. Also 54% respondents stated that design problems are not set in relation to the global perspective or, by cross-referring to global scale or, exploring the

[2] Other participating colleges included the Gateway College of Architecture and Design and the Hindu School of Architecture, both located in Sonipat and affiliated to DCRUST. The other institute that participated in the survey is the School of Architecture, MM University, Ambala.

[3] Students from other participating colleges were of 5 year undergraduate program in architecture whereas students from DCRUST, Murthal comprised of both the Undergraduate Program in Architecture as well as Graduate Programs in Urban and Rural Planning and Sustainable Architecture.

[4] Teachers who conducted design studios were drawn from a spectrum of specialties in architecture, such as Architectural Education, Urban Planning, Sustainable Architecture and, Conservation of Built Environment. One of the studios of 5th Semester at Department of Architecture, DCRUST, Murthal, in fact, was conducted on an experimental mode by an expert in Architectural Education and a PhD Researcher. The objective was to integrate various theory and studio courses synergistically and sustainably, but students did not respond due to a lack of a systematic and coordinated approach.

Table 2: Statement of Design Problem.

SN	Parameter	Mean	Mode	Standard Deviation
1	Did the design problem carry detailed information: Site, Objectives, Methodology and Deliverables, Stages of Presentation and, Evaluation Criteria?	2.66	2*	0.91
2	Before introducing design problems, is students' consent taken, or brainstorming carried out for types of projects to be undertaken?	1.97	1*	1.16
3	How often is the project site a real one, with factual site details made available? If yes, are frequent site visits arranged by faculty?	2.25	1*	1.04
4	Were the case studies and visits conducted by faculty accompanied by detailed methodology of conducting the study and presenting findings, including surveys, questionnaires or structured studies?	2.24	1*	1.05
5	Is adequate literature survey or literature review conducted to understand the nature of the project?	2.49	2*	0.86
6	How often are design problems related to the global-perspective, by cross referring to the global scale or exploring international expertise and philosophies?	2.36	1*	1.17

1*: Rarely; 2*: Sometimes; 3*: Often; 4*: Always

work of international experts and their philosophies. Thus, prima facie, design teachers' understanding and intent of the design problem handed to students, as well as their efforts on conducting effective pre-design studies appear to need major improvements.

4.3 Design Studio Conductance

The outcome of the studio hinges around the way the studio is conducted. The question then arises as to how far the information and communication from various sources is useful to students in producing and presenting their design. The input from various sources was analysed with 47% students reporting the use of internet sources and only 14% attributing their knowledge to teachers' inputs and feedback. 25% students acknowledged inputs in design and improvements in their work to discussion with senior students and their own classmates (Figure 1).

It is clear from Table 3 that students have frequent discussions with teachers and the time schedules of design studios are adhered to. But, it is also noteworthy that 56% respondents expressed that they are not encouraged to use innovative practices or, creative thinking or, out-of-the-box concepts or, abstract notions in design. It was confirmed by 70% of respondents that rarely do teachers offer 'Hands-on Experiences' to students by using the 'Doing-it-yourself' approach as

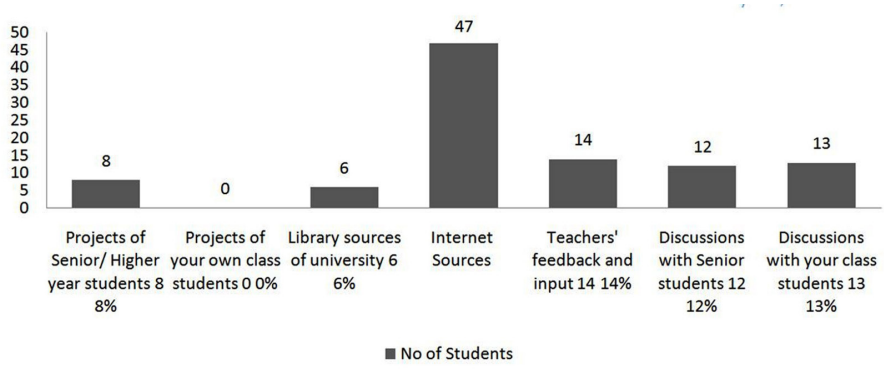

Figure 1: Analysis of various sources consulted by students for producing and presenting designs (Image Source: Author)

Table 3: Approaches to Design Studio Conductance.

SN	Parameter	Mean	Mode	Standard Deviation
1	Do frequent discussions take place between students and faculty at various design stages, with sufficient time given to students?	3.25	4*	1.14
2	How often do you find your teacher conversant with / confident about technology / software available for design and research to enable smart outcomes?	2.75	2*	1.01
3	How often do your teachers encourage you to use contemporary IT / digital technology in the Studio?	2.56	3*	1.05
4	How often does your teacher adhere to the given time schedule for various stages of design solution?	3.4	3*	1.1
5	Are you left on your own in studios and results / design solutions expected without active participation of studio supervisors?	2.94	2*	1.29
6	Do your teachers encourage you to use innovative practices or, creative thinking or, out-of-the-box concepts or, abstract notions?	2.28	3*	1.02
7	Do your teachers deliver lectures on various aspects of the design problem in the studio so that these become aids in problem solving?	2.66	2*	1.12
8	How often are hands-on experiences offered by teachers so as to participate in problem solving as a single team of teachers and students?	2.04	2*	0.89

1*: Never; 2*: Rarely; 3*: Sometimes; 4*: Often; 5*: Always

a role model. There is, thus, a very bleak possibility of the teacher and the student working as one team in problem solving. Also 57% respondents confirmed that studio teachers leave students on their own in studio and just expect results / design solutions to emerge without their own active / fruitful participation.

4.4 Design Studio Communication

The need of the hour is to be a part of an interdisciplinary team and using the 'Integrated Design Studio' approach. However, 70% of students admitted to a complete absence of team work, of working on interdisciplinary projects with other engineering disciplines, as well as of teaming up in community-led projects as a part of their design studio (Figure 2).

Through various questions, an attempt was also made to investigate how students communicate with their teachers and among themselves and, how they identify themselves with the design studio. It was found that 66% of respondents were satisfied with the outcomes of their design projects (Figure3). However, 38% students do not find any "*Connect*" and 35% students find partial connect. Connect between a teacher and a student is very vital so that the students can freely express their ideas, feelings or thoughts.

As regards respondents' views on whether discussions between teachers and students are conducted in a democratic way and are fruitful, nearly 72% students felt that design studio teachers tend to be autocratic, repressive, impose their ideas on students, or that they do not give space to students to innovate (Figure 4). Only 27% respondents confirmed that teachers keep discussions focused and contextual, whereas 41% students affirmed that teachers corroborate ideas positive points of students for design evolution.

From Table 4 it is clear that 53% of respondents are hesitant to have interactive dialogue with instructors for design solutions. 45% of students confirmed that their teachers shared / posted useful information through format of PPT lectures / video conferences / papers or through social media network. 58% Students revealed that their teacher does not prefer social media applications like WhatsApp, Facebook, Skype, etc. to enhance a faster flow of communication, while 69% respondents revealed that their Design Studio teacher is not able to resolve conflict successfully through constructive dialogue. Thus, more effective communication between teachers and students has to be introduced and sustained for better design outcome in the studio.

4.5 Design Studio Evaluation

Critiques and evaluation of student's work in the Design Studio is a key performance indicator for a student. It enables building up the design

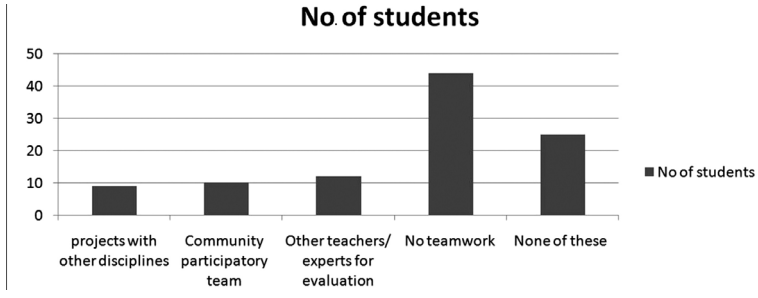

Figure 2: Analysis of levels of interaction between team members in Design Studios (Image Source: Author).

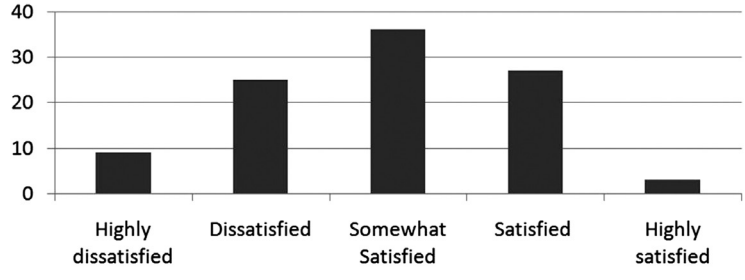

Figure 3: Level of students' satisfaction with their project outcomes in the Design Studio (Image Source: Author).

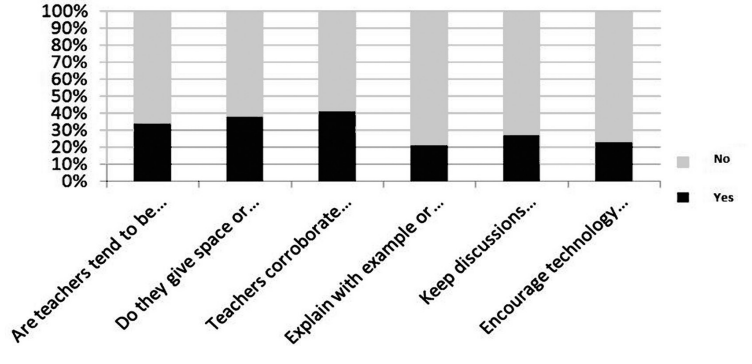

Figure 4: Comparison of students' perception of studio discussions as democratic and fruitful (Image Source: Author).

Table 4: Levels of Communication in Design Studios.

SN	Parameter	Mean	Mode	Standard Deviation
1	How often are studio discussions and discourses of high quality and healthy for design evolution?	3.02	3*	0.95
2	How often do you hesitate to initiate interactive dialogue with instructors for design solutions?	3.01	4*	1.21
3	How often does your teacher make use of social media applications like WhatsApp, Facebook, Skype, etc. for communication?	2.37	1*	1.23
4	How often does your teacher share information as PPT lectures, videos, conference papers or, classroom lectures on social network?	2.71	1*	1.29
5	Do your teachers motivate / encourage/ facilitate you for publishing your work or research in journals or departmental magazine?	2.04	1*	1.27
6	Is your work displayed in the form of public exhibitions so that others can learn from your design solutions and you can learn from others?	2.34	1*	1.25
7	Does your teacher hangout with you sometimes in an informal way and provide holistic answers to your queries ?	1.88	1*	1.14
8	How successfully does your design studio teacher resolve conflict through constructive dialogue ?	2.12	2*	0.80

1*: Never; 2*: Rarely; 3*: Sometimes; 4*: Often; 5*: Always

solution in a progressive manner, motivating students and reaffirming the value of students' work, both at the philosophical and the technical level, thus encouraging students to develop methodologies to further their design strategies (Hassanpour et al, 2011). Properly detailed and articulated marking criteria, objectively assessing various components of the design solution and its presentation, will not only bring transparency, but also enable the students in identifying specific strengths and weaknesses of the solution presented by them. A Criteria-based Model should be adopted for effective assessment of the project outcomes with respect to meeting the stated objectives of the problem which, in the first place, should be framed in collaboration with students.

This section of the survey explores the understanding of Design Jury's evaluation criteria from students' perspective and their satisfaction levels with the marking. Table 5 illustrates that 60% of the respondents confirmed that the jury invariably fails to take into account the stated thrust area of the studio. 55% confirmed that they are not encouraged to evolve their design by making models at every stage. 55% of students felt that the solutions offered by teachers do not lead to problem solving in a simple and clear manner. 53% of students are not satisfied with their marks due to the absence of precise

Table 5: Assessment of Design Studio Evaluation.

SN	Parameter	Mean	Mode	Standard Deviation
1	How transparent are the teachers in awarding marks, with pre-defined criteria of evaluation?	2.81	2*	1.22
2	Do the suggestions offered by teachers lead to problem solving in simple, clear and direct manners?	2.43	2*	0.75
3	How often are you encouraged to evolve designs by making models at every stage?	2.38	2*	0.90
4	How often has your Final Jury (portfolio assessment) paid attention to the thrust area of the studio during evaluation?	2.17	3*	0.94
5	How satisfied are you with your marks in design studio along with marking criteria, if any?	2.67	2*	1.05

1*: Never; 2*: Rarely; 3*: Sometimes; 4*: Often; 5*: Always

marking criteria, while 64% agreeed to transparency in awarding marks with pre-defined criteria of evaluation. It is clear that nearly 50%of students are not satisfied with evaluation of their designs and, thus, do not feel motivated about actively pursuing the work done in the design studio.

A list of various factors which may be considered significant by teachers in evaluation of design solutions was drawn after discussion with both undergraduate and graduate students. Students' choices were ranked on Likert Scale from 1 to 5 as Not Important, Slightly Important, Important, Very Important and Essential. As shown in Table 6, stars were assigned by students based on ranking, depicting order of significance. Similarly, ranking of one or two hashes was assigned to parameters which, according to students' perception, are not considered significant by teachers in evaluation. The survey also looks at the mode / frequency of votes assigned to 'Not Important' and 'Slightly Important' options. Thus, the factor of 'Functional or Operational Solution' was considered most significant while other factors such as 'Adjacency Matrix and Circulatory System', 'Climate-responsive Design' and 'Building Geometry', 'Context in relation to Time, and Space', 'Urban / Rural Design', 'Safety and Security' and 'Aesthetics of Spaces and Materials' were considered highly significant or, significant to quite some extent.

However, the contemporary design practices such as net-zero or carbon-neutral buildings, interdisciplinary research and team, design evaluation and visualisation by computers (BIM) or, mathematical modeling, reverse engineering for design objectives, forecasting and scenario analysis, disaster management and risk analysis, design based on iterative process, design in global perspective, etc. are not considered significant by the majority of students.

Table 6: Ranking of Various Factors Considered Significant by Teachers in Evaluation of Design Solutions.

SN	Parameter	Not important & Slightly Important (%)	Important, Very Important & Essential (%)	Whether Important
1	Site Responsive Architecture	43	57	*
2	Global Perspective	61	39	##
3	Contextuality in Time, Space and Urban / Rural design	32	68	***
4	Cultural Identity of Place	42	58	*
5	Functional or Operational Solution	16	84	****
6	Adjacency Matrix and Circulatory System	31	69	***
7	Climate Responsive Form	33	67	***
8	Geometry of Building Envelope	28	72	***
8	Unique Structural Systems	57	43	#
9	Cost-effective Solutions	45	55	*
10	Building in Relation to Landscape Planning	42	58	*
11	Services and System Planning	40	60	*
12	Optimise Performance, Productivity and Flexibility	52	48	#
13	Safety and Security	28	72	***
14	Aesthetics of Spaces and Materials	29	71	***
15	Literature Review to Study Contemporary Practices	46	54	*
16	Interview with Experts as per Building Typology	57	43	#
17	Data Collection and Analysis in Surveys	44	56	*
18	Clear Program Formulation before Design	45	55	*
19	Logical Evolution of Design or Rationalism	47	53	*
20	Design Ideation by Metaphor, Analogy, Experimentation	50	50	#
21	Graphics or Presentation for Reinforcing Design Idea	38	62	**
22	Applied Design Skills and Techniques	35	65	**
23	Integration of Theory Courses in Design	53	47	#
24	Community Participatory Approaches	59	41	#
25	Design based on Iterative Process	63	37	##
26	USP or Highlights of Design Outcomes	42	58	*

27	High Technology and ICT	58	42	#
28	Construction Systems	48	52	#
29	User Behavior, Needs and Aspirations	34	66	**
31	Innovative Concepts	30	70	***
32	Inclusive Planning	30	70	***
33	Universal Design Parameters	55	45	#
34	Design with Nature (Naturalism)	45	55	*
35	Smart Designs	45	55	*
36	Futuristic Utopian Design	56	44	#
37	Disaster Management and Risk Analysis	59	41	##
38	Integrated or collaborative design Approach	56	44	#
39	Interdisciplinary Research and Team work	68	32	##
40	Design Evaluation & Visualization by Computers (BIM), etc.	57	43	##
41	Forecasting and Scenario Analysis	67	33	##
42	Reverse Engineering for Design Objectives	65	35	##
43	Energy Efficiency Techniques	43	57	*
44	Renewable Energy Integration	49	51	#
45	Green Building Approaches	42	58	*
46	Net Zero or Carbon Neutral Buildings	56	44	##
47	Multi-functional Multi-dimensional Design	49	51	*
48	Sustainable and Innovative Materials	32	68	**
49	Recycled Materials and Waste Materials	46	54	#
50	Regenerative or Bioclimatic Approaches	58	42	#
51	Environmental Impact	40	60	**
52	Conservation of Built Heritage and Adaptive Reuse	44	56	*

* Significant; **Quite Significant; *** Highly Significant; # Less Significant; ## Not Significant

The factors which are considered less significant are ‘Design ideation by metaphor or analogy’ or ‘Experimental method’, ‘Regenerative or bioclimatic approaches’, ‘Recycled materials and waste materials’, ‘Renewable energy integration’, ‘Futuristic Utopian Design’, ‘Universal design parameters’, ‘High Technology and ICT’, ‘Unique structural systems’, ‘Construction systems’, ‘Integration of theory courses in design’, ‘Community-based participatory approaches’, ‘Optimization performance, ‘Productivity and flexibility’, etc.

It is very clear that the students as well as teachers have failed to appreciate the need of the hour and the current scenario of ever-competing architectural practices in the global as well as the national perspective, especially as regards introduction of the integrated design approach and the critical issues of sustainability.

4.6 Design Studio Infrastructure and Resources

The sixth section of the survey aimed at understanding problems related to the essential physical infrastructure available in design studios for facilitating their role as living laboratories. Studios and school are equipped rather poorly or inadequately for realizing students' projects using the "Working-on-models" approach. The same holds true in respect of Wi-Fi facilities, electrical sockets, design softwares, printing facilities or plotters and availability of stationery items. The students are least encouraged to use the 'recycle-reduce-reuse' concept for their own drawings and models.

The physical environment plays a pivotal role in architecture design studios. As shown in Table 7, the redesign of studio layout and furniture was advocated by 55% of respondents. This is coupled with the need to provide better ambience (86%), lounge spaces and furniture for resting or discussions (82%), locker / storage spaces (80%), acoustic comfort (72%), thermal comfort (60%) and, cleanliness and dustbins (60%).

In the last section, various open-ended suggestions were invited from students and they used this platform to narrate their problems and as well as suggest changes in the existing system and traditional methodologies, keeping in tune with the fast-changing technology regime.

CONCLUSIONS

A paradigm shift in the existing approaches to various aspects of learning, teaching and evaluation of the work done in the design studio and its contextual relevance is a prerequisite for enabling young graduates to face challenges of the current and future architecture practice. Modern tools for exploring information and technology, transparency and participatory role of various actors involved, team building, etc. are to be harnessed in teaching and learning systems and in addressing the real-world issues. Reflective views can help in improving human resource by intertwining technology interface with students' and teachers' participation, leading to high performance delivery and growth.

Primarily, the Design Studios need to be completely restructured and reoriented for the following:

a. Gearing up for current and emerging challenges: It is important to tailor university curricula to suit changing needs of society, incorporating

Table 7: Availability of Design Studio Infrastructure and Resources.

SN	Parameter	Yes	No	Significance
1	Are there adequate model making facilities available in studios/ labs?	18	72	####
2	How often are you encouraged to recycle or reuse waste/ residue/ earlier models/ used colored drawing sheets in model making?	19	81	###
3	Do your studio/labs have adequate facilities such as Wi-Fi/ Broadband / UPS / Design softwares / Extra electric sockets / reprography and sufficient stationery items?	37	63	##

Highly Acute Problem; ###Acute problem; ## Moderately Acute Problem

notions of sustainable buildings, using renewable energy systems, using an analytical design approach, and introducing interdisciplinary research-based designs -- thereby equipping students with the vision, knowledge and skills to operate in a global perspective. University courses and their structure should be market driven, forecasting future trends in the industry, using state-of-the-art technology to bolster research that can be responsive to market demands and changing needs of society.

b. Industry-institute Interactive Forums can be potentially harnessed to develop research that addesses national and international issues. There is a need to recreate close integration of academia and architecture practices driven by competitive markets, and encourage innovations for upgrading obsolete and depleting technologies. Therefore, our architectural schools have to continue dialogue with the industry by being proactively engaged and flexible so as to bring change in the society and credibility to their institutional framework (Weerasakera, 2011).

c. Another important issue raised in this paper is of enhancing learning by the fourth dimension of social development, i.e., the model of Four Dimensional Learning (4D-L). Universities act as potential living laboratories for envisaging the roadmap to resolve community-level, city-level, national and transnational issues. They should act as *avantgarde* for innovative practices by using students' potential, as well as disseminating knowledge and pushing boundaries to boost development and inclusive growth. The projects introduced in design studios should be multifaceted and multi-disciplinary, based on realistic issues having a community-based or a national perspective. Learning in institutes should be collaborative and four-dimensional, for example by integrating or grouping of students

first horizontally (by forming teams within a class -- One Dimension); Vertically (by forming teams across levels and years within same discipline -- Two dimension), diagonally (by forming inter disciplinary teams -- Third Dimension) and, around real time axis of community outreach and development by community participation process -- the Fourth Dimension.

d. A smart, market driven education system can be achieved by integrating Information and Communication Technology (ICT) to provide an interface between students and industry for improved delivery. ICT can play a significant role in developing and upgrading existing education systems much more efficiently. Online examination, giving instantaneous score card and analysis of students' strengths and weaknesses, choosing modules or credits as per choice of students within the same discipline or interdisciplinary courses, appearing in examination at one's own discretion, etc., can provide flexibility to various stakeholders, saving significant time and manpower and, thus, leaving scope for carrying out innovations in design studios. Smart classrooms should be a norm rather than an exception so as to have interactive dialogue between students and teachers, whether within confines of a physical space or a virtual classroom that can be accessed and shared by different schools of architecture.

e. Today's generation, i.e., the 'Generation Y' or 'Millennial Generation' of digital technology, Facebook and other social media are already using social sites and cloud computing for private sharing. They can contribute more effectively if universities also adopt cloud-based computing for various services and products. Teachers interacting with students can be more responsive in addressing queries of students in real time and can post useful lectures, conference proceedings, assignments and share loads of information on the network. Students can prepare projects as interdisciplinary virtual teams at their leisure, innovate and devote more time to research and upload them on departmental websites and social media sites for sharing with others. Similarly, by the use of ICT, one can take advantage of state-of-the-art knowledge of other universities trans-nationally to form a global village for keeping abreast with latest research and developments elsewhere. All this will provide better chances to boost research and innovation, motivating students to contribute in a collaborative manner in meeting the challenges of society and environment.

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