Research Article

Teaching fire safety through design-based immersion of National Building Code-2016 provisions to students of undergraduate architecture: a student feedback on the pedagogy technique

Raja Singh[1]

1. Department of Architecture, School of Planning and Architecture, India

This study is based on the feedback received from students of 3rd year Architectural undergraduate degree at a leading architectural education college in India. This degree in India leads to a professional license to practice as an architect in India. The study tests the design based immersive integration of National Building Code 2016 and its fire provisions into the curriculum in order to overlay fire safety interventions on design projects familiar to students. The detailed course pedagogical structure has been presented. For feedback, an 11 point questionnaire was circulated which was answered by 32 students in anonymous mode in order to prevent any conflict of interest. The results show an overall positive response where the students prefer a design integration based fire safety curriculum which introduces fire codes to the students in the applied format.

Corresponding author: Raja Singh, dr.rajasingh@proton.me

Introduction

This paper takes feedback from students for a pedagogy that was used to teach students of 3rd year bachelor of architecture[1]. This pedagogy involves the integration of the Part 4 of the National Building Code 2016[2] into the curriculum. Focus was specially on integrating provisions of the code through building design rather than plain theory with students overlaying the fire provisions on the drawings of their existing academically introduced building design projects. Anonymised feedback was taken to

 doi.org/10.32388/8D4636.3

check the effectiveness of the course from the students and the importance of teaching fire safety through design and integration of codes into buildings has been highlighted in this study.

Literature Background

Fire protection may be neglected in schools of architecture as according to one study, it may be considered as an 'engineering thing"[3] In other studies too, it is believed that the fire safety system may not always be considered seriously in the building design and reasons attributed are lack of coordination between fire engineers and architects; difficulty and complexity of fire codes and expensive cost of fire installations. [4]

Due to the lack of effective teaching in architecture schools, some studies go on further to state that fire safety must be made a separate course and its teaching in separate modules may not be enough. [5]

In recent years, practitioners from Spain, state that in architecture classrooms the shift has been made from simply reading of legal requirements of fire to making an attempt to see the graphical or drawing based representations of fire safety in building plans. [6]

The basic requirement is the visual translation of the complexity of the fire codes that exist and this is possible by hands-on integration or immersion of the fire codes into design exercises and implementation of the codes in live building plans.

Need for the Study

There have been fires that cause damage to life and property in buildings across the world. Fire prevention is a key and must be integrated into the buildings. The course of Architecture has a very limited exposure to a dedicated module on fire which lasts for one semester. There may be teaching on fire but is incidental in the architectural design courses. Building plan approvals also demand thorough integration of National Building Code 2016 into building approvals. Architects in practice may depend upon fire engineers and consultants, but the integration of codes into the design at the early stages of a building project may be necessary. Literature studies have shown a neglect for fire safety teaching to students of architecture and this learning may need to be more design immersive. This paper introduces a pedagogy which tries to bridge the possible gap in applied fire safety and its instruction to students of architecture. This pedagogical technique also introduces the comprehensive integration of National Building Code 2016 into the architectural design school at mid undergraduate level, as we will see there is

a gap as far as knowledge of Part 4, Fire and Life Safety from National Building Code 2016 is concerned. The study is further strengthened by the feedback received from the students who underwent the course. The anonymity of the students ensured unbiased feedback.

Aim of the Study

To test a design based approach of immersion of National Building Code 2016 into the curriculum of 3rd Year Architecture students through student feedback.

Objectives:

1. To introduce a new pedagogy to teach Fire Safety to students of Architecture at the undergraduate level.
2. To base the pedagogy to a design immersion based methodology which focusses on design integration through applied fire safety principles.
3. To see the familiarity of the students with the provisions of the National Building Code 2016, especially the provisions of Part 4: Fire and Life Safety.
4. To integrate the fire safety into design by implementing the provisions of the Part 4: Fire and Life Safety of the National Building Code 2016 into the curriculum.

This paper also shows an attempt made by the author to do the following:

1. Integrate Part 4-Life and Fire Safety of the National Building Code 2016 into the curriculum of third year architecture students.
2. Make the integration from mere reading of the Code to translating the same into an existing design project in order to get a completely immersive learning experience.

About the National Building Code 2016

The National Building Code 2016 is also known as Special publication No. 7, which is a compilation of the various standards developed by various committees of the Bureau of Indian Standards under the lead of the Civil Engineering Department. It consists of 13 Parts starting from Part 0 to Part 12. This is further divided into various sections and sub sections totalling upto 33 chapters[7]. This is a recommendation guideline that has been provided by the Bureau of Indian standard with the aim of providing a standardised building level guideline for the whole of India [8]. Its adaptation is done by various state

governments in parts because land, buildings and urban law is governed as a state legislature subject or a municipality level subject in India. Of our special interest is the Part 4 of the National Building Code 2016 which is titled as Fire and Life Safety and deals with three major features, i.e., Fire Prevention, Life Safety and Fire Protection. It has been adopted by many local buildings bye laws to be followed as a mandatory provision with some customisations made from state to state, with Delhi for example making most parts mandatory to be followed, atleast with a legal check on certain buildings of particular size and use[9] .

About the Course

The fire safety course was taught from August to November 2022 Semester at the School of Planning and Architecture, New Delhi. It was part of the Subject that dealt with building services titled: 'HVAC, Mechanical Mobility and Fire Safety' taught to students of 3rd year or 5th Semester of Bachelor of Architecture or B.Arch [1]. This course is a 2 hour per week lecture course with internal and external examination consisting of equal marks. B.Arch is a five year professional programme leading to an undergraduate degree in Architecture. This finally leads to a license to practice architecture in India by registration to the Council of Architecture, New Delhi.

The objective of this course as per the syllabus is acquaint students with systems for fire safety, codes relevant to them and incorporation of the systems in building design. The anticipated learning outcomes for fire were that students be able to interpret and depict fire safety requirements in design & drawings. This course is in line with the the Council of Architecture (Minimum Standards of Architectural Education) Regulations, 2020[10] made by the Council of Architecture under Section 45 read along with Section 21 of the Architects Act 1972[11]

The Pedagogical technique of the Course

The Methodology for the Course is presented in Table 1.

S. No.	Title of the Course Methodology Step	Description of the Course Methodology Step	Remarks
1.	Case Study of a Model Building with State of the Art Fire Safety Provisions integrated into Design	A building was which had state of the art fire safety was selected and permission for a site visit was requested. The site visit was executed by the Fire Expert from the organisation which was visited. Students were made to touch and feel fire safety equipment and understand the various design interventions that were made to make the building fire safe.	The students were taken to an active mass transit transport station which was underground and heavily equipped with fire safety mechanisms
2.	Sensitisation of importance of Fire Safety in Buildings by News reported cases.	The students were presented with multiple newspaper reports about fire incidences where there was a loss of life and property. The students were make to study the highlighted points regarding the lapses in architectural design and non compliance of fire codes which contributed to the gravity of loss in the fire incidences. Lapses may be lack of ventilation or totally sealed windows. [12]	The fire instances highlighted were that of the Mundka Fire Case in Delhi, along with other fire cases. [13]
3.	Reading through Part 4 of National Building Code 2016 and creating a Step by Step flowchart of actionable steps.	This is a major step where a very bulky and text based code was translated into a flowchart based actionable steps that the students could easily follow at the drawing board stage and this will serve as a ready reckoner for the student.	The students had to have a graphical flowchart with arrows and the clause mentioned explicitly from the code in it. The flowchart sample is shown in Figure 1.
4.	Getting the drawings for a building project ready for future integration of fire provisions into it.	This is a very important step as in this the students were asked to compulsory get a studio project that they had designed in the past so that they have full familiarity with the design of the project. Integrating fire safety measures, if not already done, will be easier as the students will be able to compensate for other design considerations and the building brief accordingly.	The students chose the projects from their previous semester design studio. The typology was public and the students mostly had one of the following: 1. Museum 2. Primary School 3. Community Centre 4. Primary Health Care Centre.

doi.org/10.32388/8D4636.3

5.	Integrating the Flowchart based actionable steps into the existing building plans under exercise.	The actionable steps collated in he flowchart will be implemented in the design project selected. In order to fine tune the broad principles, the students were to refer to the details in the code along with other related standards mentioned in the code in order to make an appropriate design. The students were to mark the fire safety interventions as an overlay on the building plans with proper notations and make a note of the calculations in the legend itself. The students were only to give the overlay as a submission so that their inclination, as architecture students, to make drawings is further enforced.	The students made a thorough effort to write down the calculations, step by step as a legend in the drawing sheet itself along with all the fire notations that were given by showing an actual sheet of another project made by a fire safety consultant.

Table 1: The detailed step by step Course methodology for the semester long course designed to teach fire safety to students of Architecture.

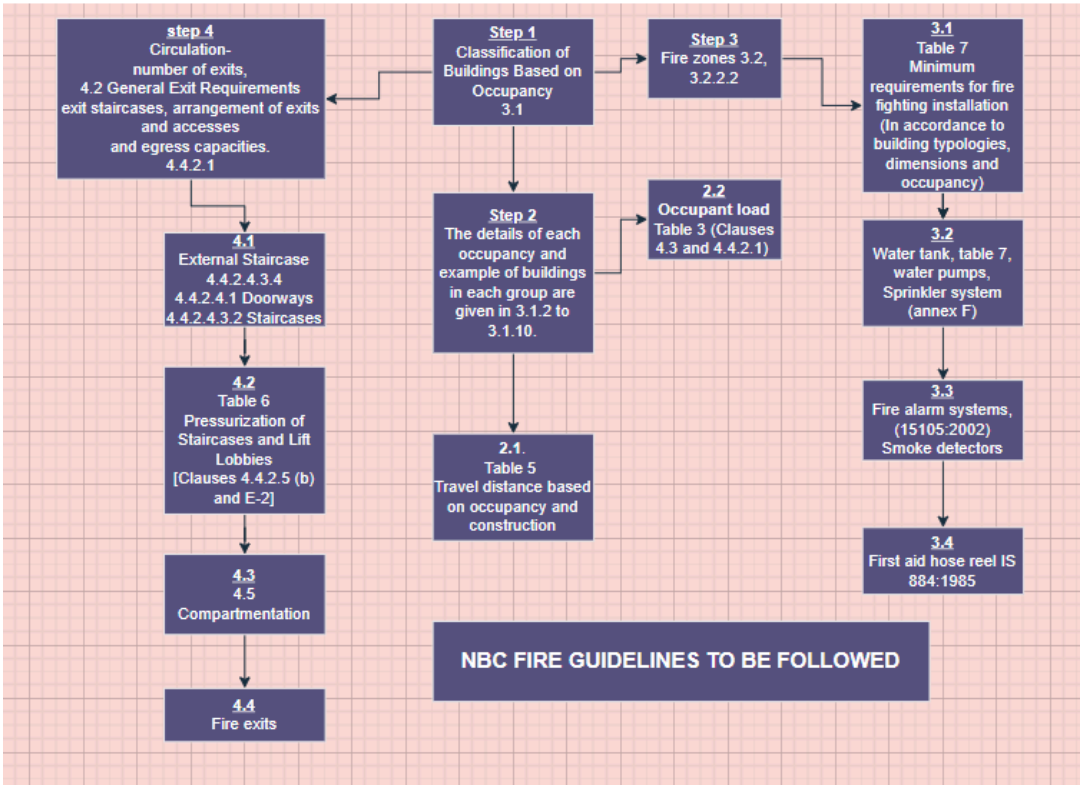

Figure 1: The flowchart prepared by a student of the class which creates an easy graphical list of actionable steps in order. Source: Deepanjana Das/SPA Delhi

Methodology

The Step by Step Methodology followed for this study is as follows:

1. A full semester course was taught to students of 3rd Year Bachelor of Architecture at the School of Planning and Architecture, New Delhi. This course was part of the combined subject to teach building services.
2. After the full course was completed, the feedback questionnaire was created to be circulated among the students.
3. The students were given the option to fill the questionnaire in an anonymous mode where they had the option of not filling their name and class section. 11 questions in total were asked.
4. The results of the questionnaire were collected, compiled and reported.

The total number of students who were enrolled in the class was 86 out which 32 filled the questionnaire. This means that the sample had a confidence level of 95% with a margin of error of 14%.

The questionnaire was in the form of an Online Google Form based questionnaire titled 'Anonymous Survey on Fire Class' which had the following questions:

1. Name (Optional) as students could fill the form anonymously.
2. Class and Section (Filing is optional)
3. Did you attend one or more class on Fire Safety in Buildings this Semester? (Yes /No/Other)
4. Is asking students to make fire safety provisions on Design Sheets itself a good idea.(5 point Likert Scale with 1 as 'Not Great for Learning' and 5 as 'Very Good Idea for Learning')
5. What has been your exposure to the National Building Code before this class? (5 point Likert Scale with 1 as 'Not Familiar at All' and 5 as 'Very Familiar')
6. Should students be introduced to the National Building Code at a stage earlier than Third Year? (Yes/No/Other)
7. How easy was it for you to grasp the Fire Portion of the National Building Code, by the end of the semester? (5 point Likert Scale with 1 being 'Challenging' and 5 being 'Easy')
8. Did the method of the class instruction make you understand the positive role of Architects in Fire Safety in Buildings. Rate. (5 point Likert Scale with 1 being 'Not Really' and 5 being 'Understand the Positive Role Well')
9. Was the teacher well prepared to sensitise about Fire Safety in Buildings? (5 point Likert Scale with 1 being 'Not prepared' and 5 being 'Well Prepared')
10. Should students be taught a lot of fire theory or should be immersed into design integration?(Likert Scale with 1 being 'Theory Based' and 5 being 'Design Integration Based')
11. Any suggestions. Please write, if possible. It will help in furthering the class in the future.

The answers for question number 3 to 11 were compulsory to be answered. Question number 1 and 2 were purely optional in order to retain the anonymity of the survey. Answer 11 was general feedback which consisted mainly as aforum for students to present some difficulties they may have faced.

Results and Analysis

The results of the questionnaires are presented from question 4 onwards. In all of the Likert scale based studies, an incremental likert scale has been used with 1 side usually being the negative value and the 5 side being the most positive values. The points 2, 3 and 4 would usually means that 3 is neutral and 2 being more inclined towards value at 1 and 4 being more inclined towards value at 5.

The interpretation of the average values can be made from the following table 2:

Weight	Range of Values	Interpretation Generally in Incremental Order
1	1.00-1.80	Strongly Disagree
2	1.81-2.60	Disagree
3	2.61-3.40	Neutral
4	3.41-4.20	Agree
5	4.21-5.00	Strongly Agree

Table 2: The range of values to be used for intepretation of the weighted values with 0.8 as the difference between two values.

The first of the questions discussed was whether making fire safety provisions on design sheets a good idea in itself. The results are presented in Figure 2 below:

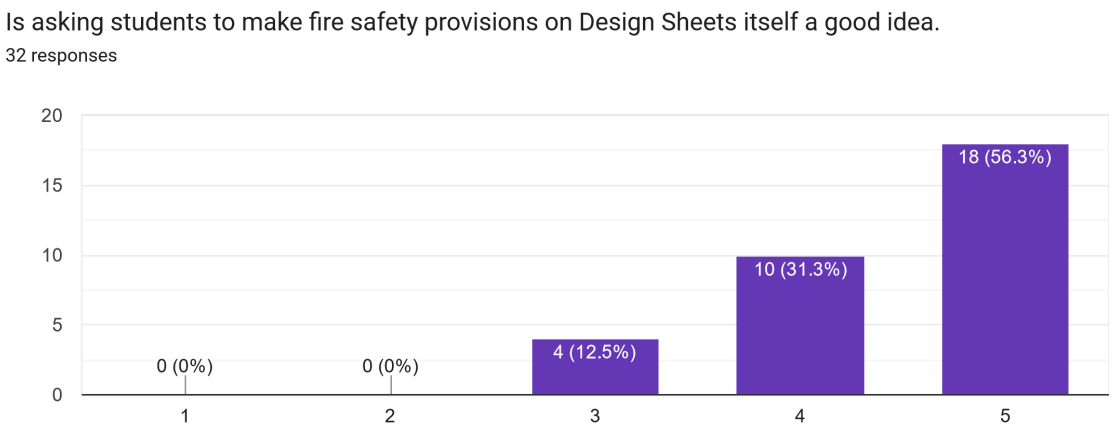

Figure 2: In this, 1 is to be read as 'Not Great for Learning' and 5 is to be read as 'Very good idea for learning'

The second question asked was to judge the exposure of the students to the National Building Code 2016 which makes the reader understand the gap that exists in familiarising important building codes for

doi.org/10.32388/8D4636.3

students of architecture at the second half stage of their architecture professional curriculum. The average value in this case is 4.4 which means that the respondents on average agreed to the weight '5' which means that asking students to make fire provisions in design sheets is a 'very good idea for learning'

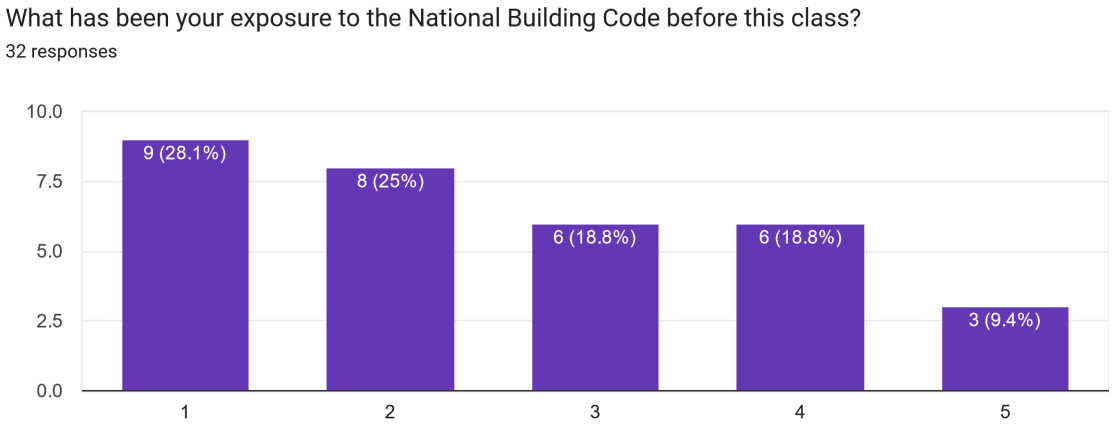

Figure 3: In this figure, 1 represents 'Not Familiar at All' and 5 represents 'Very Familiar'

In the above Figure 3, the average value was 2.56 which means that the respondents in the polarised scale gave the answer as '2' which is one weight lesser than 'Not familiar at all'

doi.org/10.32388/8D4636.3

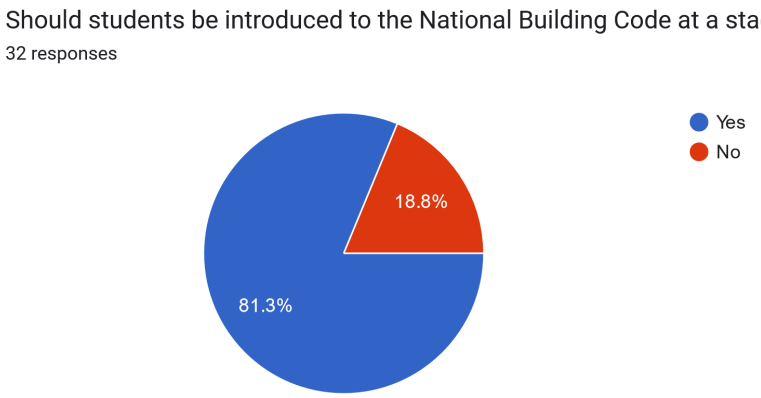

Figure 4: The answer to the question about early introduction of National Building Code to students of Architecture

In the above Figure 4, the students were asked about whether National Building Code 2016 should be introduced at a stage earlier than 3rd year to which the students answered in the positive with 81.3% students giving yes as an answer.

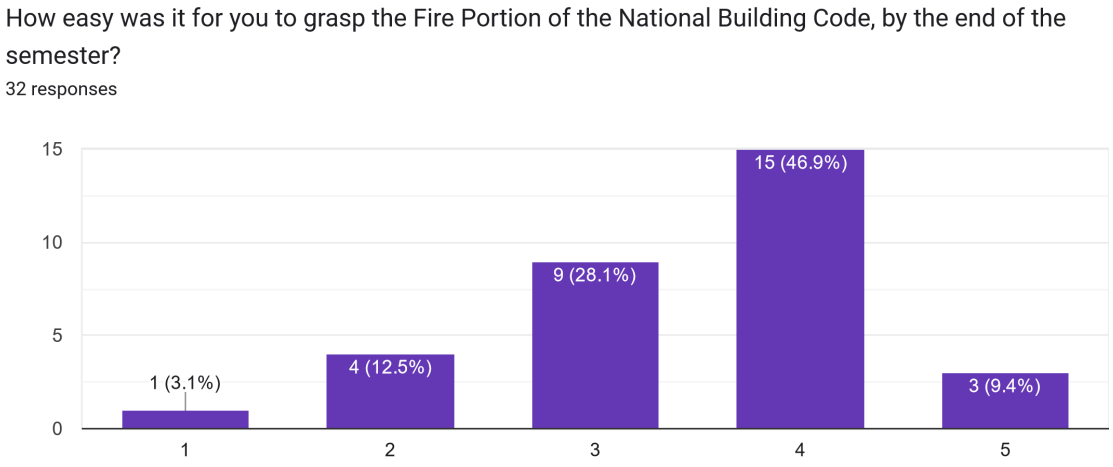

Figure 5: In the above '1' represents the polarised value 'Challenging' and '5' represents the polarised value 'Easy'

doi.org/10.32388/8D4636.3

In the above Figure 5, the average value was 3.47 which categorises it in the weight '4' which would mean that the respondents on average would agree instead of strongly agree for the easiness of grasping the fire portion of he National Building Code 2016 by the end of the teaching semester.

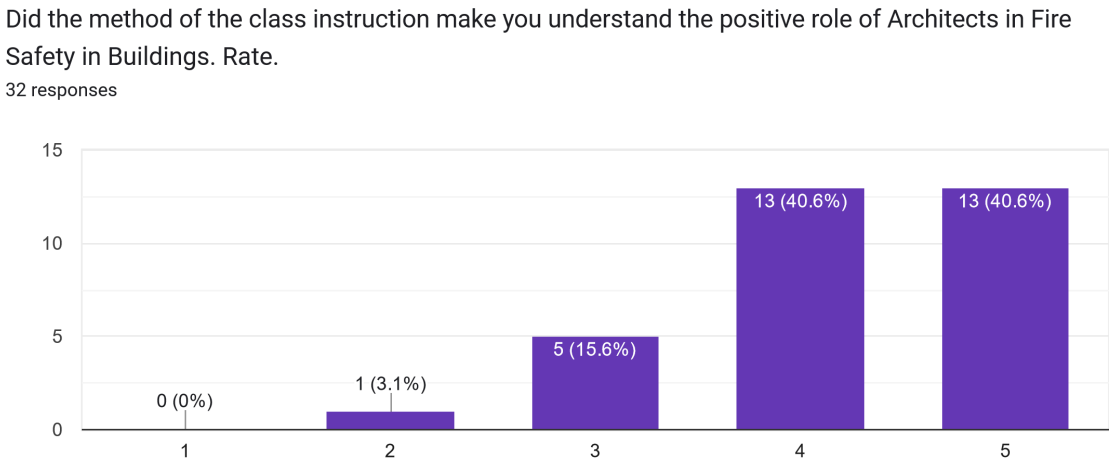

Figure 6: In the above '1' means 'Not Really' whereas '5' represents 'Understand the positive role well'

In the above Figure 6, the average value came out to be 4.19 which categorises it be in '4' which means that instead of strongly agreeing to 'understand the role well' the average of the class responded as 'agree' which would mean that the respondents agree that the method of class instruction made them understand the positive role of Architects in fire safety in buildings.

doi.org/10.32388/8D4636.3

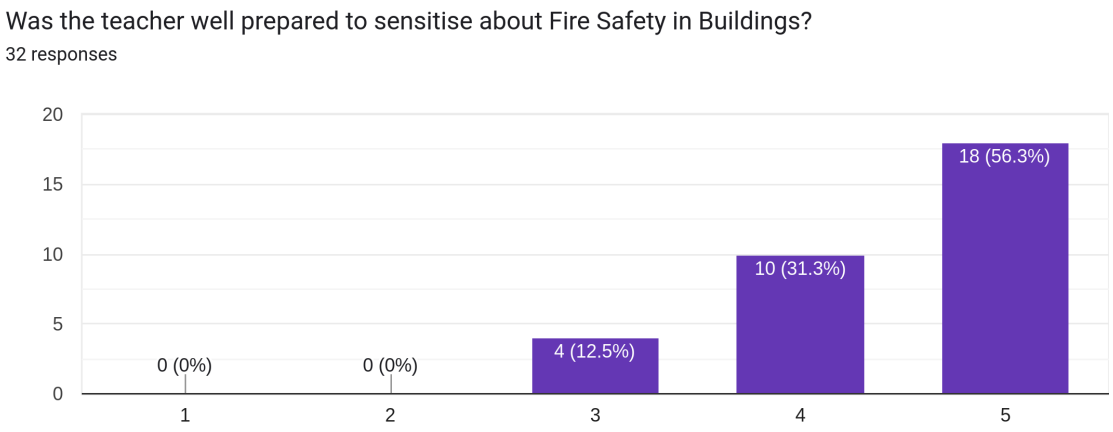

Figure 7: In the above, '1' is 'Not prepared at all' and '5' is 'Well prepared'

In the above Figure 7, the average value came out to be 4.44 which categorises it in the value of '5' which means the respondents on average rated the teacher to be well prepared to sensitise students about fire safety in buildings.

This next question was very important to gauge the theory vs the design integration based learning types that the students preferred for their comprehensive learning of fire safety in buildings.

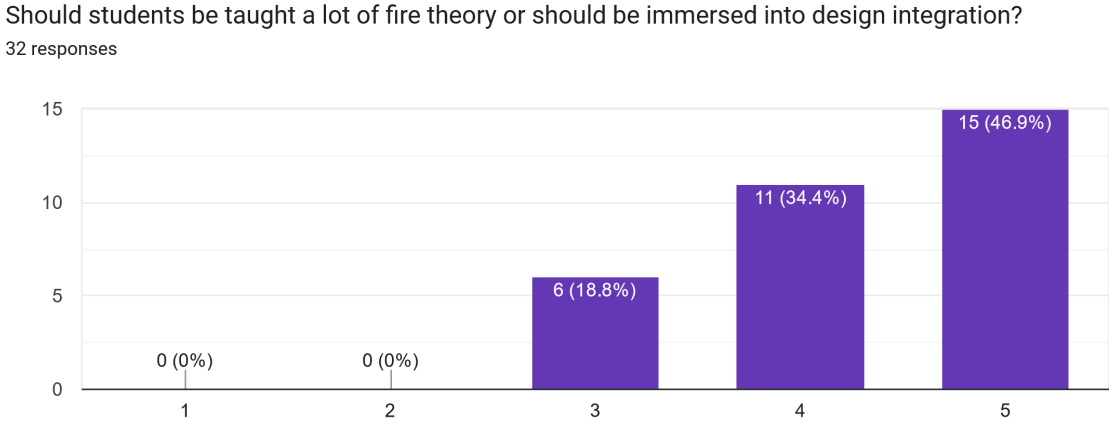

Figure 8: In this figure, the polarised entry 1 means 'Theory Based' and 5 means 'Design Intervention Based'

doi.org/10.32388/8D4636.3

In the above Figure 8, the average value was 4.28 which categorises it into the category of ‘5’ which means that the respondents on average wanted Design Intervention based teaching instead of theory based fire safety.

The results in totality can be summed up in the following Table 3.

doi.org/10.32388/8D4636.3

S. No	Question	Average Weighted answer	Interpretation
1	Is asking students to make fire safety provisions on Design Sheets itself a good idea.(5 point Likert Scale with 1 as 'Not Great for Learning' and 5 as 'Very Good Idea for Learning')	4.44	It means that asking students to make fire provisions in design sheets is a 'very good idea for learning'
2	What has been your exposure to the National Building Code before this class? (5 point Likert Scale with 1 as 'Not Familiar at All' and 5 as 'Very Familiar')	2.56	It means that the respondents in the polarised scale gave the answer as '2' which is one weight lesser than 'Not familiar at all' which would mean not familiar.
3	Should students be introduced to the National Building Code at a stage earlier than Third Year? (Yes/No/Other)	Yes	81.3% respondents stated a Yes
4	How easy was it for you to grasp the Fire Portion of the National Building Code, by the end of the semester? (5 point Likert Scale with 1 being 'Challenging' and 5 being 'Easy')	3.47	It means that the respondents on average would agree instead of strongly agree for the easiness of grasping the fire portion of he National Building Code 2016 by the end of the teaching semester.
5	Did the method of the class instruction make you understand the positive role of Architects in Fire Safety in Buildings. Rate. (5 point Likert Scale with 1 being 'Not Really' and 5 being 'Understand the Positive Role Well')	4.19	It means that instead of strongly agreeing to 'understand the role well' the average of the class responded as 'agree' which would mean that the respondents agree that the method of class instruction made them understand the positive role of Architects in fire safety in buildings.
6	Was the teacher well prepared to sensitise about Fire Safety in Buildings? (5 point Likert Scale with 1 being 'Not prepared' and 5 being 'Well Prepared')	4.44	It means the respondents on average rated the teacher to be well prepared to sensitise students about fire safety in buildings
7	Should students be taught a lot of fire theory or should be immersed into design	4.28	It means that the respondents on average wanted Design Intervention based teaching instead of

	integration?(Likert Scale with 1 being 'Theory Based' and 5 being 'Design Integration Based')		theory based fire safety.

Table 3: The summary of the results of the study

Discussion

As we have seen earlier that fire safety integration into the curriculum of architecture students needs more detail, vigour and attention. Many instances of fires happen in buildings where some architectural intervention or lack of it is the cause of the fire[14]. There are studies which have even stated that architecture education does not provide enough focus to fire safety as may be needed. [3][14][6][15] In India, there are many instances of fire where there are flouting of building codes or fire norms[13] Many Indian Building Local Bye Laws depend upon the provisions of the National Building Code 2016 for fire safety provisions. This makes the teaching of National Building Code 2016 very essential from the not only the fire safety point of view, but also other building safety and design considerations. The results show that the awareness about National Building Code 2016 among students of Architecture at mid degree level may not be adequate as there is evidence to state that the code should be introduced very early in the degree program.

Another very important point is the visual nature of Architecture Education and the need to focus from simply theory based learning to a learning which integrates the applied portions of the building services segment to the drawings so that the process becomes seamless for students and they can relates to the subject all the more.

The case study of a building is an essential pedagogy techniques as it is even a step higher than integration into the building design as the students would be able to see the physical manifestation of a design intervention in reality.

Conclusion

The study started with the aim to test a design based approach of immersion of National Building Code 2016 into the curriculum of 3rd Year Architecture students through student feedback. The results have shown a very positive response with most students in the favour of a design based immersive approach

where the principles of National Building Code 2016 are integrated into the design through overlays into the drawings of the building project familiar to the students. The study also shows the need for an early and more detailed interaction of students with the provisions of the National Building Code 2016. Architectural educational institutes must increase the scope and intensity of fire safety education in schools of Architecture.

Acknowledgements

First and foremost thanks to School of Planning and Architecture, New Delhi which is an institute of National Importance under the Ministry of Education, Government of India. The author would most humbly like to thank Dr. Anil Dewan, Professor and Head, Department of Architecture, School of Planning and Architecture, New Delhi for kind encouragement to perform this study and to let this subject be taught by the author. Special thanks to all the students who were part of the class with special thanks to the class representatives Akansha, Mehul, Priya and Vishwal for their assistance in the class. Special thanks to co faculty of other subjects and the studio directors at the School of Planning and Architecture, New Delhi. Also special thanks to Prof. Dr. Tadepalli Srinivas for guiding my masters project at my masters college on Fire in Buildings.

Most Special thanks to Group Captain P Aanand Naidu of the Tathatara Foundation and Rakshekhar Pullabhatla of the Information Sharing and Analysis Center, India.

Special thanks to Qeios. Thanks to all the people who work hard to make our buildings safe against fire. Cover image source: Vashishth Dhamija/SPA Delhi

Declarations

The authors declare no conflict of interests. There was no special funding taken for this study.

References

1. [a], [b]*School of Planning and Architecture, New Delhi. Syllabus for Bachelor of Architecture (Effective from Academic Year August 2016).*
2. [^]*Bureau of Indian Standards. (2016). National Building Code 2016: SP 7.*
3. [a], [b]*Martín-Gómez, C. (César) orcid researcherid scopusid Mambrilla-Herrero, N. (Natalia) Zapata-Martínez, O. (Omayra) Villanueva, S. (Sonia) Echeverría-Trueba, J. B. (Juan B.). (2013). Architectural Fire Protection Lea*

rning: the ETSAUN Case. 39th World Congress on Housing Science Changing Needs, vol. ISBN: 97888649302 06 . Politecnico di Milano, Italia.

4. ^*Rahma M. Doheim. (2020). Early Integration of Fire Safety Objectives between Architects in Academia an d Practice. WIT Transactions on Engineering Sciences, vol. 129 .*
5. ^*Ebenehi I, Ruikar K, Thorpe T, Wilkinson P. (2016). Fire safety education and training in architecture: an ex ploratory study. Proceedings of joint international conference - 21st Century Human Habitat: Issues, Sustai nability and Development, Federal University of Technology Akure, Nigeria, 21-24 March 2016..*
6. a, b*Juan Bautista Echeverría, Maria Fernández-Vigil. (2022). Teaching Fire Safety in Schools of Architecture. doi:10.4018/978-1-6684-5053-6.ch010.*
7. ^*Bureau of Indian Standards. Guide for using National Building Code of India 2016.*
8. ^*Raja Singh, Manoj Mathur, Anil Dewan. (October 2022). Analysis of the Delhi Unified Building Bye Laws 2 016 with respect to the Integration of the provisions of the National Building Code. Shelter, vol. 23 . Hudco.*
9. ^*Raja Singh. (2022). [Commentary] Can we ensure Fire safety in Buildings that don't require NOC from the Fire Department?. doi:10.32388/p6jsu5.*
10. ^*Council of Architecture, Government of India. The Council of Architecture (Minimum Standards of Archite ctural Education) Regulations, 2020.*
11. ^*Government of India. Architects Act 1972.*
12. ^*Raja Singh, Anil Dewan. (2022). Openability of windows and presence of wire mesh in residences in a New Delhi neighbourhood as a factor of dilution ventilation required for prevention of airborne diseases and vec tor borne diseases. Cities & Health. doi:10.1080/23748834.2022.2036003.*
13. a, b*Paras Singh. (May 2022). Delhi: Mundka building a firetrap, flouted an array of norms, say officials. Hin dustan Times.*
14. a, b*Nat Baker. Architecture education has "shifted away" from fire safety, experts say on Grenfell anniversar y. June 2022. Dezeen.*
15. ^*Ezgi Korkmaz. (2016). An investigation of the status of fire safety design in architectural education. Megar on. doi:10.5505/megaron.2016.07279.*

Declarations

Funding: No specific funding was received for this work.

Potential competing interests: No potential competing interests to declare.