DOI: 10.24191/ijsms.v8i1.21901

Students' Perceptions towards Assignment Integration between Architecture Design Studio and Structural and Technological Subjects

Ruzanah Abu Bakar[1*], Atta Idrawani bin Zaini[2], Siti Syariazulfa binti Kamaruddin[3] and Raja Nur Syaheeza Raja Mohd Yazit[4]

[1,2,3,4] Faculty of Built Environment, Universiti Malaysia Sarawak (UNIMAS) Kota Samarahan, Sarawak

[1]abruzanah@unimas.my; [2]izzata@unimas.my; [3]kssyariazulfa@unimas.my; [4]rmysyaheeza@unimas.my

**Corresponding Author*

Received: 3 January 2023
Accepted: 14 March 2023
Published: 31 March 2023

ABSTRACT

Architecture is a process of planning, designing, and constructing buildings or structures. In architecture, structural and technological aspects need to be considered in the design process for better service. Architecture Design Studio (ADS) is the fundamental course of the Architecture Programme. It teaches students about the design process and techniques via design projects. Courses on structure and technology (S&T), on the other hand, teach students technical knowledge. In the evolution of the University Malaysia Sarawak (UNIMAS) architecture programme, these two - ADS and S&T - are integrated to enhance critical thinking and design ability. Integration is achieved by requiring students to apply the knowledge that they have gained in S&T courses to their design projects in ADS. This study investigated the perception of students towards this integration. Respondents were from Year 2 and Year 3 students undergoing their Bachelor of Science (Honours) in Architecture at UNIMAS. The data

analysis gathered from the questionnaire based on 59 respondents showed that the majority of students had a positive attitude towards this integrated assignment, and with adequate execution and support from lecturers, this approach to improving critical thinking in architecture design projects may grow and succeed in the future.

Keywords: *architectural education; structural knowledge; technological knowledge; integration*

INTRODUCTION

Architecture Design Studio (ADS) is widely recognized as the backbone of architectural education in all architecture schools. Design is taught as a domain subject, while all S&T subjects are taught to serve and enhance design quality. With the current rapid growth of building technology, architectural education must keep pace and provide sufficient qualitative knowledge, particularly technical knowledge, to assist architectural students in meeting up the 21st-century expectations of development. Academicians and practitioners are accountable for the growth of architectural education as providers and transmitters of knowledge. Paying insufficient attention to S&T knowledge may result in the loss of values in architecture, resulting in unfavourable architectural design imbalances.

Bachelor of Science (Honours) in Architecture of UNIMAS has been accredited by the Council of Architectural Accreditation and Education Malaysia for a full five (5) years. As such, the curriculum structure is recognised and up to the standard. One of the requirements of accreditation is to have ADS integrated with other non-studio subjects such as S&T. This has been implemented via assignment integration between ADS projects and S&T courses in the teaching and learning process where students need to apply the knowledge that they have gained in the technical class into their design. The purpose of this integration is to elevate students' design ability and critical thinking and to apply their understanding of theoretical knowledge to practical design. This study investigated the perception of UNIMAS architecture students towards this integration via an online questionnaire.

DOI: 10.24191/ijsms.v8i1.21901

LITERATURE REVIEW

Architecture is a professional sector that necessitates specialised and cutting-edge abilities, as well as the participation of a team of professionals, such as engineers and quantity surveyors, each with their unique set of skills. The team must be assembled in accordance with the project's requirements, and it must engage in constructive discourse with the designer to arrive at long-term structural, technological, and engineering solutions. The architect's role as a designer shifts at this point, where architects become key figures who must have a sufficient understanding of all construction sectors to be able to converse professionally and make decisions in partnership with professionals from each area (Garavaglia et al., 2020).

The S&T issues of the building design are some of the most difficult aspects of architecture. Previously, master builders were responsible for all aesthetical, technical, and structural concerns of design, but, during the industrial revolution and the division of skills, architecture and structural engineering emerged as two distinct professions. To prevent an architectural idea from being only an expression of creativity, a rational analysis must occur first. This perspective began with Alexander's (1964) and Broadbent's (1979) literature which touched on the architectural design process, which was based on three levels of rationality: analysis, synthesis, and appraisal. This methodical approach combines rational analytic judgement with emotive creative goals to provide a precise concept and construction process. The flexibility of modern structural materials should encourage architects to create more imaginative forms. As a result, the construction process necessitates more than just drawings and other legal documents like specifications, construction details, and the selection of a specific structural system that is appropriate for both the building's form and function (Fahmi et al., 2012).

Some of the architect's responsibilities in responding to S&T parts of the design are often overlooked, leaving structural engineers to tackle the problem. According to Arundathi and Satishchandra (2021), many engineers and architects have come to believe that the interests and sensibility of others in the field are mutually exclusive over time, is untrue. Architects gradually have come to believe that engineers are responsible for handling the technical aspects of structure; they are not involved in the design process and must adhere to the limitations and standards established

by the architects. Failing to carefully consider structural issues during the design process may harm the integrity of the building. The preliminary structural design of buildings plays a key role in the overall design process since it is a gradual evolution of an idea with some back-and-forth process. Architects are genuinely interested in structural design from an aesthetic standpoint (Yilmaz, 2021). Considering the negative consequences of inadequate attention to structural design concerns during the design stage brings attention to the need for architecture education in the training of architects who are capable of critical thinking and solving multiple aspects of design at the same time.

Unay (2006) stresses the importance of design studios and their structural teaching in architectural studies, as well as the need for theoretical architecture courses to support the creative and scientific objectives of design courses. Students studying architecture should be knowledgeable on the capabilities and limitations of building structures, as well as how to choose the appropriate system (Saghafi & Crowther, 2020). Graduate students should be able to demonstrate knowledge of architectural technology and how it affects design outputs (e.g., Architect Accreditation Council of Australia). There is a necessity in an ADS to promote maximal creativity through the understanding of all disciplines involved. This can be accomplished by adopting an interdisciplinary and transdisciplinary learning style, as opposed to an intradisciplinary and multidisciplinary style, in which creative design is explored inside a single subject without taking into account any other discipline's requirements (Saridar, 2017).

The requirement to educate architects on structural function, proper load transmission, and the sizing of structural elements has caused structural teachers to ponder on what should be the optimum technique for teaching these disciplines to architects (Vassigh, 2005; Salama, 2008; Uihlein, 2013; Sgambi et al., 2013; Sgambi et al., 2019). Although the S&T curriculum in the UNIMAS Architecture Programme was mostly taken from the engineering syllabus, there are some differences in understanding the knowledge between engineers and architects. Engineers deal with mechanical knowledge which requires them to do extensive calculations on the loads, while the most important thing for architects is to understand the behaviour of the structure. It is crucial that they can visualise or picture how the building form responds to loads and behaves under stress, rather than learning how to calculate it. Architectural students are visual learners, thus

DOI: 10.24191/ijsms.v8i1.21901

creativity is strengthened by visualisation (Vassigh, 2005). While having a solid understanding of structural mathematics is an advantage, it is not necessary for a design studio (Aziz et al., 2010). What students need is a kind of structural knowledge that can assist them in developing their design projects, focusing on the fundamental concepts of structural design where students can differentiate the types of loads and how students may consider them in structural design. According to Moore (1999), the only types of structure that students need to understand are basic ones, like span restrictions, economics based on design specifications, the structural grid or scheme, and span-to-depth ratio. Furthermore, it is crucial to understand how the structural system interacts with building functions. According to Fahmi et al. (2012), structure systems should be taught as a space-defining element and integrated with design projects where students are required to provide structural actions relative to plans and sections based on their design. A collaboration between the structure class and the studio design is one way to improve and emphasise the synergy between ADS and S&T courses (Ochshorn, 1991).

The ADS, which is taken every semester, can be integrated with the S&T subject via the assignments to enhance the understanding of technical knowledge. The primary idea behind architectural education is that creativity must be managed and organised in accordance with laws and standards to meet realistic requirements, which can only be met through rational building structures and construction. This integration of assignments not only allows students to be creative in their design but requires them to consider certain limits regarding the feasibility of structure and construction to make their building buildable and realistic. With these exercises, students can improve their critical thinking and decision-making for their design. Creative designs without a suitable and logical selection of structure, technology, and construction method will still be questionable regarding functionality and buildability. Students must be creative in both design and structure and construction method selection. A smart architect should be conscious of how the structural systems influence the aesthetic component of design (Aziz et al., 2010). With these exercises, students use their design proposal in ADS and integrate it with their S&T subject assignment. Integration is also reflected in ADS design proposals. The course integration happens in the same semester. For example, Year 2 students enrol in BEA2136 Architecture Design Studio 4 in semester 2, as well as the S&T, subjects BEA2153 Building Services 1 and BEA2143

Building Technology 2. Among these subjects, integration takes place in the assignments and design proposals.

METHODOLOGY

Study Participants

The respondents (n = 59) were Year 2 and Year 3 students of the Bachelor of Science (Honours) in Architecture programme from the Faculty of Built Environment, Universiti Malaysia Sarawak (UNIMAS). The analysis focuses particularly on Year 2 and Year 3, in which the integration of various S&T subjects with ADS is extensive.

Survey Instrument

A total of 79 questionnaires were distributed to the students via an online survey through Google Forms, and 59 (74.7%) responses were obtained. The survey consisted of four sections. Section A covers general information and demographic of students, such as year of study, ADS courses they have taken, and S&T subjects they have enrolled into. Section B (five items) deals with the perception towards the application of S&T knowledge in the design process. Section C (four items) deals with respondents' understanding of the task itself, their opinion on the feedback given, and the weightage of the assignment's mark. Section D (five items) investigates the awareness of the level of integration of S&T in their design. Items used a Likert scale measurement of 1 to 5; 1=Very Disagree (VD), 2=Disagree (D), 3=Neutral (N), 4=Agree (A), 5=Very Agree (VA). Participation in this survey was voluntary.

Data Analysis

Data were recorded and tabulated for all instruments using Microsoft Excel software. Percentages of each response were calculated. Results were analysed and presented using descriptive statistics. Tables 1 to 4 show the results from the four sections.

Results

The number of Year 2 students was 44, while Year 3 students were 35, for a total of 79. The overall response rate was 74.7% (n=59), in which 29 (49.2%) were Year 2 students and 30 (50.9%) were Year 3. There were 30 female respondents (50.8%) and 29 male respondents (49.2 %) (Table 1).

Table 1
Demographic characteristics

Variables	Participants (n=59)	
	No	%
Gender		
Male	29	49.2
Female	30	50.8
Academic Year		
Year 2	29	49.2
Year 3	30	50.9
Architecture Design Studio		
1 (Semester 1 Year 1)	59	100%
2 (Semester 2 Year 1)	59	100%
3 (Semester 1 Year 2)	59	100%
4 (Semester 2 Year 2)	30	50%
5 (Semester 1 Year 3)	30	50%
6 (Semester 2 Year 3)	-	-
Technical Subjects		
BEA 1083 Building Technology 1	59	100%
BEA 2143 Building Technology 2	59	100%
BEA 1083 Building Technology 3	30	50%
BEA 2153 Building Services 1	59	100%
BEA 3202 Building Services 2	30	50%
BEA 2113 Survey of Architectural Structure	59	100%

Students started learning S&T subjects during Semester 2, Year 1 of their studies. Since Year 1 students were still in Semester 1 during the research period, this study focused on Year 2 and Year 3 students. BEA 1083 Building Technology 1 is taken in Semester 2 Year 1 and covers the procedures for building construction. BEA 2113 Survey of Architectural Structure is taken in Semester 1 Year 2, covering construction in practice

and fundamental structural elements. Semester 2 Year 2 includes BEA 2143 Building Technology 2 and BEA 2153 Building Services 1. BEA 2143 Building Technology 2 covers the components of a building system, techniques of the fabrication process, and procedures of construction in a building. BEA 2153 Building Services 1 covers the basic concepts and design principles of plumbing, drainage, electrical systems, and services, which are crucial in making buildings comfortable, convenient, and safe. The current year 3 students were enrolled in Semester 1 Year 3, which includes BEA 1083 Building Technology 3 and BEA 3202 Building Services 2. BEA 1083 Building Technology 3 covers advanced construction techniques applied in the building. BEA3203 Building Services 2 covers the fundamental principles, engineering concepts, design procedures, practical applications, and related codes/standards of HVAC and fire services systems. These technical subjects are integrated into the ADS every semester through assignment tasks.

The second part of the survey (Table 2) shows the perception towards the application of S&T knowledge in the design process. One respondent (2%) very agreed, and 23 (39%) agreed that they have difficulty relating the knowledge learned from the S&T subject with the real-life building/project. Fifteen (25%) respondents believed they did not have any problem relating their theoretical knowledge to real-life practice, whereas 20 (34%) of them were not sure. A majority of respondents (38, 64%), agreed and 6 (10%) very agreed that the integration of exercises increased their understanding of S&T subjects, while 36 (61%) agreed and 6 (10%) very agreed that it improved their design decisions in ADS projects. Despite this, about half of the respondents (27, 46%) agreed and 4 (7%) very agreed that they faced difficulty in design because of the need to apply S&T knowledge that they have learned. Twenty-three (39%) of the respondents were not sure and 5 (9%) thought they did not have any difficulty in design due to the integration. Even though it was quite difficult for them to integrate, 23 (39%) agreed and 10 (17%) strongly agreed that S&T knowledge played a bigger role in their design, while 20 (34%) respondents were not sure and 6 (10%) did not agree with this statement.

Table 2
Perception towards the application of S&T knowledge in the design process

Variables	Participants, n (%)				
	VD	D	NS	A	VA
Having difficulty to relate the knowledge that they have learned from the structure and technology-based subject with the real-life building/ project	3 (5%)	12 (20%)	20 (34%)	23 (39%)	1 (2%)
The integration task with Architecture Design Studio projects has increased students' understanding of learning the structure and technology-based subjects	-	1 (2%)	14 (24%)	38 (64%)	6 (10%)
The integration has improved students' design decision in Architecture Design Studio projects	-	-	17 (29%)	36 (61%)	6 (10%)
Facing difficulty in designing due to the existing structure and technology knowledge that have been learned before in class	-	5 (9%)	23 (39%)	27 (46%)	4 (7%)
The structure and technology knowledge play a bigger role in students' designs	-	6 (10%)	20 (34%)	23 (39%)	10 (17%)

Table 3 shows respondents' understanding of the task, their opinion on the assigned mark, and the feedback given to them. It conveys whether the students were aware of and understood their tasks for the integration assignment. Thirty-one (53%) agreed, and 1 (2%) very agreed that they were clear with the assignment briefing given to them; however, it was quite worrisome that 19 (31%) respondents were not sure whether they understood the task through the briefing given, and another 8 (14%) were unclear. Thirty-three (56%) respondents agreed, 3 (5%) very agreed that they were aware of the total marks for every task given, 17 (29%) were not sure, and 6 (10%) were not aware. The awareness of total marks is important as it may indicate the level of seriousness towards the assignment. If the mark is too little, it may not be suitable for the intensity of the task, and that

may lead to students arguing about the mark allocation. 25 (42%) agreed, and 3 (5%) very agreed that the task (such as axonometric drawings, reports, etc.) was sufficient for the integration in enhancing their understanding of S&T knowledge. Meanwhile, almost half of the respondents (26, 44%) were not sure whether the current task assignments were sufficient in enhancing their technical knowledge or not, and 5 (8%) thought it was not sufficient. Twenty-nine (29) respondents (49%) agreed and 6 (10%) very agreed that the feedback given by the studio lecturer was sufficient during the ADS face-to-face assessment, while 19 (32%) were not sure, 3 (5%) disagreed and 1 (2%) very disagreed.

Table 3
Understanding the task and opinion on the assigned mark & feedback given

Variables	Participants, n (%)				
	VD	D	N	A	VA
The assignment briefing given is clear for students to understand the task	-	8 (14%)	19 (31%)	31 (53%)	1 (2%)
Aware of the total marks for every task given	1 (2%)	5 (8%)	17 (29%)	33 (56%)	3 (5%)
The given task (such as axonometric drawing and report, etc) is sufficient for the integration in enhancing understanding of structure and technology knowledge	-	5 (8%)	26 (44%)	25 (42%)	3 (5%)
Feedback from the studio lecturer is sufficient during Architecture Design Studio face-to-face assessment	1 (2%)	3 (5%)	19 (32%)	29 (49%)	6 (10%)

The final part of this survey, as shown in Table 4, investigates the awareness of the level of integration of S&T in their design. Thirty-one (59%) respondents were not sure if their integration of technical knowledge was highly applied in their studio project, 12 (20%) agreed and 1 (2%) very agreed that they have applied a high level of technical knowledge in their design while 10 (17%) disagreed and 5 (8%) very disagreed. The integration and application of S&T knowledge are considered effective if the students can explain well each component and specification used and its connection to the building. Some students employed specifications without knowing exactly why. Is it functional? Does it suit the design? Good integration is where they can explain and demonstrate each technique of construction,

structure, and technology that they use with good justification and reasoning. The majority of respondents (34, 58%) agreed, and 8 (14%) very agreed that they were aware of their weaknesses in structural understanding and had poor integration of structure in their design projects. The number of respondents who consulted the lecturer on structural decisions and applications of technology in their design was reasonably high, with 33 (56%) agreeing and 2 (3%) very agreed.

Table 4
The Awareness level of integration of S&T in their design

Variables	Participants, n (%)				
	VD	D	NS	A	VA
Integration and application level on structure and technology knowledge are high in students' design project	5 (8%)	10 (17%)	31 (53%)	12 (20%)	1 (2%)
Aware of weakness in the structural understanding and poor integration of structure in students' design projects	-	2 (3%)	15 (25%)	34 (58%)	8 (14%)
Consultation with the subject lecturer on the decision of the structure and technology application in students' design	-	6 (10%)	18 (31%)	33 (56%)	2 (3%)
The intensity of research on the possible building technology and structure has increased	-	-	22 (37%)	34 (58%)	3 (5%)
This integration should be continued for students' understanding of structure and technology-based subject	1 (2%)	-	13 (22%)	36 (61%)	9 (15%)

However, 18 (31%) of the respondents were not sure whether they have ever met for a consultation, and 6 (10%) of them have not consulted the lecturers for their technical decisions. Other than meeting lecturers for consultation, students did their own research on possible building technology and structure, with 34 (58%) of respondents agreeing and 3 (5%) students strongly agreeing that their level of research has increased for the technical solution (see Figure 1). The students were asked whether integration should be continued in the future, and overall, 9 (15%) respondents strongly agreed, and 36 (61%) agreed (see Figure 2).

Figure 1
Has the degree of research on the possible building technology and structure increased

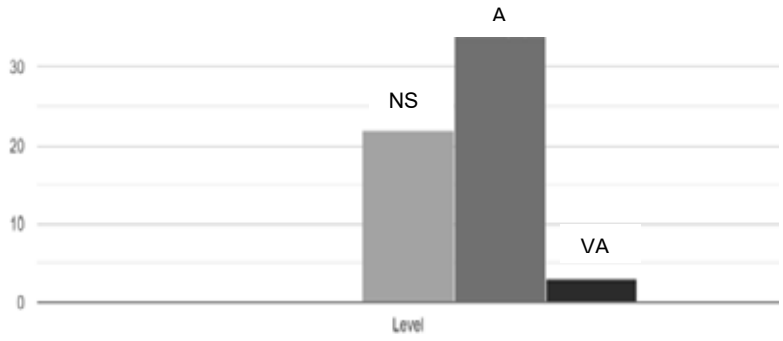
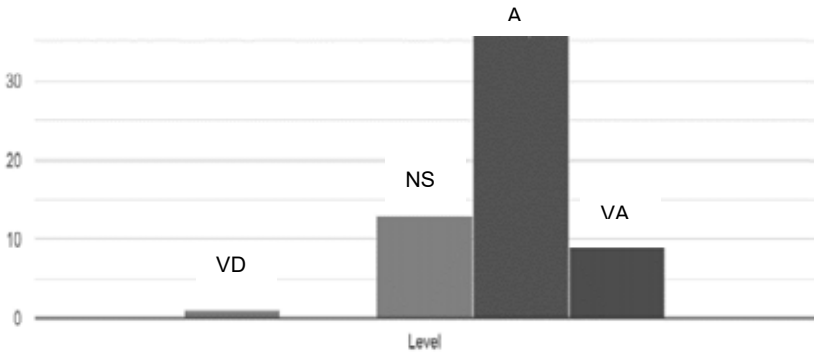


Figure 2
Should integration be continued for understanding of S&T subjects



DISCUSSION

This study has shown that most of the respondents agreed that the integration between ADS and S&T subjects had increased their understanding of S&T knowledge. Since the S&T subjects are taught through lectures, and the design studio is through hands-on drawing and 3D models, it is good for students to practice their technical knowledge by applying it on their design projects, starting from the preliminary stages of

DOI: 10.24191/ijsms.v8i1.21901

the design process. Architectural students are visual learners, so visualization in their assignments enhances their creativity and imaginative capabilities. Respondents indicated that they experienced difficulties relating the knowledge that they gained during the lecture with the real-life building. Hence, there is a need to provide exercises in which they can practice their technical knowledge in their studio project so that they can familiarise themselves with the process. One of the concerns in key design is the integration of structural knowledge in students' early design applications, lest this 'lack of concern attitude' continues when these students later become practising architects (Ochshorn, 1991). With this practice, students can understand their design through the consideration of structure and technology, which makes their design functional and buildable. Even though it is rather challenging for them to transfer theoretical knowledge into a practical approach, students agreed that structure and technology play a bigger role in their decisions and directions in design.

This study has also shed light on the students' awareness and understanding of the task itself. About half of the respondents were clear with the assignment briefs; however, the rest were unsure or claimed it was unclear. On this note, the lecturer can play a role in explaining the task further by providing an example of the outcome or expectation that students should produce at the end of the task. Marks also need to be discussed at the beginning of the given task so that students are clear on the allocated weightage. Integration is usually carried out in the final studio project, and the mark allocation can be quite high as these are high-order thinking tasks. Currently, integration tasks consist of producing axonometric drawings, schematic diagrams, reports, and models, which depend on the S&T subject the ADS is integrated with. Almost half of the respondents believed that assignments are sufficient to enhance their technical knowledge. However, the other half were not sure or even disagreed. The lecturer may try to diversify how the tasks are integrated and try other solutions, such as relating tasks to a real case study. Nevertheless, feedback given by the studio lecturer was sufficient during the ADS face-to-face assessment, as agreed by more than half of the respondents. Feedback from the lecturers towards students' work is important so that they are aware of their strengths and weaknesses.

The awareness of students towards their level of integration for S&T in their design was examined through this study. Several students were not sure if they had integrated enough technical knowledge through their design and most of the students were aware of their weaknesses in technical integration. Here, the lecturer plays a bigger role in facilitating and guide the students in their design decisions. For the lecturer to guide them, students must also do their part by providing their draft proposal accordingly so that lecturers can comment further. This task also allows students to further research on the possible S&T that can be applied based on their design. Sometimes the design may not use the conventional technique and require a different approach. Through this exercise, they can diversify their knowledge and learn about the current possible technology available. In the real scenario of a construction project, students will later experience the same process when they work in the industry. During the designing stage, they still need to consider the material, the possible structure, and the construction involved, just like the same way they experienced during their studies. This will reflect on their design and the technical drawings that they produce. This integration will train them on how to produce technical drawings based on their design.

All in all, nearly all the students agreed that this integration should be continued in the future for the understanding of S&T subjects. This survey shows that the integration has been positively embraced by the students in enhancing their understanding of technical knowledge in the S&T discipline.

CONCLUSION

The design studio is a very important part of an architect's education service. As a result, it is strongly advised that studio assignments be complimented and cross-referenced throughout the other technical modules to help students gain a better knowledge of holistic design. Students will have a better understanding of integrating structural, technological, and architectural design aspects and will be able to give ideas for the building construction system if the structure is addressed early in the design process. This study may not indicate whether the students have managed the integration successfully, rather, it focuses on the students' perception of the integration in enhancing their critical thinking in design. This study has shown that the majority of students have an encouraging view on this

integrated task and with proper execution and support by lecturers, this approach of enhancing their critical thinking in architecture design projects may be developed further and become successful in time to come.

CONTRIBUTIONS OF AUTHORS

The authors have confirmed their equal contribution in each part of this work. All authors reviewed and approved the final version of this work.

FUNDING

This work received no specific grant from any funding agency.

CONFLICT OF INTERESTS

All authors have declared that they have no conflicts of interest.

ACKNOWLEDGEMENT

We would like to express our appreciation to the Centre for Applied Learning and Multimedia (CALM), and the Faculty of Built Environment, UNIMAS which have directly or indirectly involved in the whole research process.

REFERENCES

Alexander, C. (1964). *Notes on the Synthesis of Form*. Harvard University Press.

Arundathi. M.V., & Satishchandra.K.T. (2021). Teaching Building Structures as a Subject in Architecture Studies, Sthala – A Journal of Architecture, Interior Design, Urban Design and Planning, vol. 1, p.p 29.

Aziz, A. A., Fahmi, M. M., & Bane, L. T. (2010). Integration of structural knowledge in design studio project: assessment study of curriculum in

architecture course in University of Malaya. *Journal of Design and Built Environment, 7*(1).

Broadbent, G. (1979). The Development of Design Methods. *Design Methods and Theories*, *13*(1), 41–45.

Fahmi, M. M., Aziz, A. A., Ahmend & Elhadi S. M. (2012). The Integration of Structural Knowledge in Studio Design Projects: An Assessment Curriculum in: Architecture Course in SUST, *Journal of Science and Technology*, vol. 13, https://repository.sustech.edu/handle/123456789/16555

Garavaglia, E., Basso, N. and Sgambi, L. (2020). The role of structures in architecture: The multidisciplinary experience of active learning in a master of science. Archnet-IJAR, Vol. 14 No. 3, pp. 469-488. https://doi.org/10.1108/ARCH-08-2019-0187

Moore, F. (1999). *Understanding Structures*. McGraw-Hill.

Ochshorn, J. (1991). Teaching Technology: What Do Architects Need to Know about Structures? ACSA Technology Conferences: The City and Technology Los Angeles, Stoneham, MA. Butterworth. Retrieved 30 December 2021, from www.ochshorndesign.com writings teachingtechnology.html

Salama, A. M. (2008). A theory for integrating knowledge in architectural design, education, *International Journal of Architectural Research*, *2* (1), 100-118, doi: 10.26687/archnet-ijar.v2i1.180

Saghafi, M. R., & Crowther, P. (2020). Integrating Technology subjects with Design Studio Teaching: Comparing Curriculum of Architecture Education in Australia and Iran. *Archnet-IJAR: International Journal of Architectural Research, 15*(3), 652–667. https://doi.org/10.1108/arch-08-2020-0160

Saridar Masri, S. (2017). Improving architectural pedagogy toward Better Arch structural Design values. *Athens Journal of Architecture, 3*(2), 117–136. https://doi.org/10.30958/aja.3-2-1

Sgambi, L., Basso, N. and Codazzi, M.E. (2013), "Conceptual structural design: an important topic in architectural education, structures and architecture: concepts, applications and challenges", in Cruz, J.S.P. (Ed.), Proceedings of the 2nd International Conference on Structures and Architecture, ICSA 2013, ISBN 9780415661959, CRC Press, Guimar~as, Portugal, 24-26 July, 1271-1278.

Sgambi, L., Kubiak, L., Basso, N. and Garavaglia, E. (2019). Active learning for the promotion of students' creativity and critical thinking: an experience in structural courses for architecture. *International*

Journal of Architectural Research, ArchNet-IJAR, 13(2), 386-407, doi: 10. 1108/ARCH-11-2018-0018

Unay, A. & Ozmen, C. (2006). Building Structure Design as an Integral Part of Architecture: A Teaching Model for Students of Architecture. *International Journal of Technology and Design Education*, 253–271.

Uihlein, M.S. (2013). Architectural Engineering in the Curriculum: The Case Study on AE and its Relationship to Architecture, University of Illinois at Urbana-Champaign, Building Technology Educator's Symposium-Tectonics of Teaching, pp. 3-10, available at: https://pdfs.semanticscholar.org/5853/6613205f2edc8b6373b73e7ee078680685af.pdf

Vassigh, S. (2005). *Interactive Structures: Visualizing Structural Behavior*. John Wiley & Sons.

Yılmaz, D.G. (2021). Teaching the Principles of Structural Design: Rethinking the Methods for Architecture Students. 4th International Conference of Contemporary Affairs in Architecture and Urbanism (ICCAUA-2021), 20-21 May, 2021, Alanya, Turkey DOI: 10.38027/ICCAUA2021296N14