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A Knowledge Integration Approach for Design for Safety Body of Knowledge (DfSBoK)

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Abstract
Design for Safety has been becoming increasingly important in the construction industry worldwide however it is limited in terms of integration into the undergraduate programmes curricula. Knowledge integration for Design for Safety is a necessity in order to instil a concept into the construction environment or culture. It is essential that the next generation of construction professionals learn about Design for Safety so that it can be incorporated into the culture of the industry. In order for a new concept to be successfully integrated into current Construction Designers programmes, the right and appropriate approach must be taken.. A primary focus of this paper was on the integration of the Design for Safety Body of Knowledge (DfSBoK) into undergraduate architectural and civil engineering degree programmes. Questionnaire was used as a method of data collection distribute to academicians from 26 universities that are accredited for the said programmes. The results, analysed by SPSS Statistics, found that academics are in agreement with both approaches, whether they are standalone or embedded in current courses. Despite the fact that the findings show that an embedded approach was a slightly higher approach that was preferred. In spite of this, this study suggest that a standalone strategy should be implemented because the academicians have a limited or nonexistent understanding of the concept in question. This finding significantly contribute considerably to the educational sector in overcoming challenges to incorporating design safety knowledge, namely for the architectural and civil engineering programmes respectively.
Keywords: Knowledge Integration Approach, Design for Safety, Body of Knowledge

Introduction

It can be difficult to incorporate a new topic into an established curriculum since it involves a number of recent modifications and a lack of resources. Moreover, it will be difficult to put this idea in practice in any community without a suitable implementation structure. An implementation without adequate preparation may lead to unfavourable outcomes or failure. For this to be successful, it needs a solid implementation framework in the beginning. Implementation criteria, guidelines and desired objectives are all included in the structure of the curriculum. Unexpectedly, only a small amount of funding is allocated to the

implementation of safety design principles in undergraduate programmes. Additionally, educators' lack of expertise in areas such as design safety and workplace health and safety could impede progress (Pellicer, 2012). Despite that, producing a list of design safety body of knowledge is the best and most beneficial way to get started. Many academicians in construction programmes lack training and understanding in construction safety, which is why researchers encourage the development of design safety modules to help educators overcome this barrier (Toole and Gambatese, 2008; Popov et. al., 2013; Hayne et. al., 2017; Tae et. al., 2021).

Design Safety Education is a standard body of expertise that should be acquired and applied by each construction industry's construction teams. It is essential for construction teams to have access to the same level of experience and know-how when it comes to safety in the workplace. Therefore, it is strongly important that the designers are aware of the OSH Act's safety criteria and have a general concept of how the design will be built by the contractor when designing. For this to happen, Faida and Saidin (2018) suggested three recommendations for the direction of implementing design safety in Malaysia; (1) approach curriculum in the universities, (2) additional training programmes and (3) awareness in terms of safety and health of the construction workers. Unfortunately, undergraduates are not required to learn about design safety (Samsudin et. al., 2021) but lately, many education providers are now taking this into account, and encouraging them to incorporate it into the new curriculum. With the introduction of a core course or an obligatory subject on safety in Architectural and Civil Engineering university programmes, the curriculum could be improved.

Design Safety Curriculum

At this juncture, the word “curriculum” must be adequately defined. A course syllabus provides a framework for both teachers and students to understand how and where a given topic will be taught (Murphy, 2018). A Curriculum Committee made up of members from HEP University and administrative staff, government agencies, professional bodies and industries, as well as others, is essential to a well-structured curriculum design process (MQA, 2011). The framework of the curriculum is based on a clear vision that should define the goals and results of the programme. Additionally, the framework should include a system that would map the curriculum to the stated goals and results, which reflect student interests as well as national and global trends in the subject matter. A thriving educational setting can only be achieved by ensuring that both the content and the structure of the programme are kept current with the most recent findings of the relevant studies.

The syllabus is a smaller part of the curriculum that summarises the goals, objectives, and skills needed to ensure uniformity in the entire educational system. The syllabus has 17 possible functions, including describing course content scope, identifying course goals and performance objectives, identifying reference material, motivating students, establishing an evaluation system, and meeting accreditation requirements (Murphy, 2018).

Design Safety Knowledge Approach

There are several strategies to address the lack of design safety concepts in undergraduate degree programmes. It has been suggested by Armitage et al (2011) that the new curriculum could be incorporated into the current one already in place. A number of components must be included in the current curriculum in order to implement the concepts. Batson (2013) proposes five alternatives in approaching design safety that could be incorporated into the current curriculum, namely the inclusion of design safety (1) in all

courses, (2) in all design courses, (3) in all senior capstone design courses, (4) in safety engineering courses, and (5) design for a safety course.

Lopez-Arquillos et. al (2015) suggested integrating the content within the current course by including best practices, methods, tools and case studies to match the degree precisely. In the United Kingdom, this method is now widely used, with most universities including construction site safety in their undergraduate civil engineering curriculum (Zaneldin et. al., 2014). The suggestion to integrate it as a cross-field subject is also favoured by the participants in the study (Cortes et. al., 2012). Pellicer (2012) also agrees with this approach, the reason being that hazards and risks are present in all productive sectors; thus, integrating it into the core syllabus is advisable. Batson (2013), however, questions this approach as it would require broad modules on the topic to be developed for each course. Having said that, academicians are the ones who will be required to consider all of these different approaches based on their expertise, experience, and the institutions at which they are affiliated. The study by Osofero et. al (2014) on incorporating sustainability into the curriculum found that some academicians resisted a change because they lacked the sustainability knowledge, among other issues. Pellicer (2012) is in agreement, while Batson (2013) is of the opinion that it is unlikely that this strategy will be successful.

ASCC (2006) justifies how safe design can be incorporated into the curricula. One of the steps is to keep using the design subject materials that are already available and to incorporate lessons on design safety into the activities that involve technical design. In this respect, Mann (2008) and European Agency for Safety and Health at Work (EASHW) (2010) have also proposed the same approach, that the topic of health and safety could be incorporated into the current courses instead of a completely new course. It is suggested that Occupational Safety and Health educational materials be included in every design, with the goal of addressing relevant construction techniques and methods and demonstrating how particular design decisions can influence the safety of construction workers (Suckarieh and Diamantes, 1996; EASHW, 2010). This approach is also deemed desirable by Cortes et. al (2012) to integrate occupational risk prevention as a cross-field subject in other technological courses, even if the syllabus already includes some related courses. Batson (2013) also agrees that the chances of success are good because courses with design content are most likely to refer to multiple criteria. The educators can easily teach about construction safety by referring to the safety issues for design standards and guidelines. In short, besides all the pros and cons elicited from the studies mentioned above about the second approach, Suckarieh and Diamantes (1996); Batson (2013) still have some reservations. They have noted that the current curriculum already contains a wide variety of subjects and subject areas that need to be covered in the field. Instead, students could use safety topics in report writing activities based on case studies and other reviews and observations made on operational construction sites. This would allow students to make suggestions for improvements and innovative techniques, if necessary, to enhance safety at the workplace.

According to Batson (2013), his third approach has a better chance of succeeding provided that consideration of design safety issues and expectations is included in all senior capstone design projects. As stated in RIBA (2013), although it is essential to incorporate health and safety concerns into lecture theatres, the only way undergraduate students could comprehend them and discuss them was through practical experience in the design studio. Capstone projects involve all subjects that have been taught throughout the undergraduate programmes, such as the design of a system, components, process, and concepts. Therefore,

it would be beneficial to introduce students to a design environment that is true to the real world.

Last but not least, the fourth approach, according to Batson (2013), is to include a design safety syllabus in courses such as Safety Engineering, Safety and Health, and Construction Safety. According to the findings of Batson's investigation at the Department of Civil, Construction, and Environmental Engineering, this strategy had a hundred percent chance of being successful.

Apart from Batson (2013) approaches to incorporating design safety into the current curriculum, Pellicer (2012) has outlined four approaches for occupational risk prevention in the education sector. There are (1) introduction of a new degree, (2) a new course in an existing degree, (3) inclusion of relevant topics or a cross-field subject in several courses of the current syllabus, and (4) relevant topics in one specific course in the current syllabus.

Touching on the second approach, according to Cortes et al (2012), a majority of their participants supported a separate and mandatory course in all engineering degree programmes. Pellicer (2012); Zaneldin et. al (2014) have suggested that by including core courses within the curriculum, design safety can be dramatically improved. In their study, Lowe et. al (2018) recommend employing a stand-alone strategy for academic integrity in the learning management system. Instead of being a part of the current curriculum, this will allow the educators the opportunity to monitor the development of each individual in relation to a completely different topic. With this approach, faculty members, academicians and students can evaluate the level of understanding of the topics.

Batson (2013) too strongly agrees with this approach, but suggested that it should be introduced as an elective course. As a result of his studies, it has come become successful and therefore offers the Design for Safety course as an elective for students who wish to broaden their knowledge of safety, design disciplines, or a research topic for a dissertation or thesis. However, this alternative should only be considered if a required course is not approved, according to (Cortes et al., 2012). This statement is also supported by (Pellicer, 2012; Zaneldin et. al., 2014).

Methodology

The data was collected from two separate groups of academics working in different departments within the university: the architecture department and the engineering department. Academicians were selected as the respondents for this study because of their direct involvement in the day-to-day operations of their respective academic institutions as well as their awareness of these operations. This survey includes both public and private universities; however, the research only considers universities that have earned their accreditation (at the time of this research ongoing) under the Council of Architectural Education Malaysia (CAEM) and Engineering Accreditation Council (EAC). A total of 26 universities, including 17 schools of architecture and 18 schools of civil engineering, are selected, as can be seen in Table 1 and Table 2, respectively.

There are a total of 175 questionnaires handed out, as a result of the random selection of five academics from each of the 26 universities. In the end, 109 of them are returned, with 53 coming from the first group, making up 62.4 percent of the total, and 56 coming from the second group, making up 62.2 percent of the total. According to Salvidar (2012), this number is considered to be sufficient for use in online surveys, where a response rate of 30 percent is considered to be within the average range and acceptable. In both groups, there are a greater number of associate professors and professors than there are senior lecturers and lecturers.

The Architecture department has 23 professors and 16 associate professors, while the Civil Engineering department has 15 professors and 22 associate professors. The remaining members of each group are senior lecturers and lecturers.

Table 1
List of Universities chosen for this research

No.	University	Programmes
1	Universiti Teknologi Malaysia (UTM)	Arch , C.E.
2	Universiti Teknologi MARA (UiTM)	Arch , C.E.
3	Universiti Sains Malaysia (USM)	Arch
4	University of Malaya (UM)	Arch , C.E.
5	International Islamic University Malaysia (IIUM)	Arch
6	Universiti Putra Malaysia (UPM)	Arch , C.E.
7	Universiti Kebangsaan Malaysia (UKM)	Arch , C.E.
8	Universiti Malaysia Sarawak (UNIMAS)	C.E.
9	Universiti Malaysia Pahang (UMP)	C.E.
10	Universiti Pertahanan Nasional Malaysia (UPNM)	C.E.
11	Universiti Tun Hussein Onn Malaysia (UTHM)	C.E.
12	Universiti Teknologi Petronas (UTP)	C.E.
13	Universiti Malaysia Sabah (UMS)	C.E.
14	Universiti Selangor (UNISEL)	C.E.
15	Universiti Tenaga Nasional (UNITEN)	C.E.
16	Taylor's University	Arch
17	SEGi University	C.E.
18	UCSI University Kuala Lumpur	Arch , C.E.
19	Infrastructure University Kuala Lumpur (IUKL)	Arch , C.E.
20	Politeknik Port Dickson	Arch
21	Universiti Sains Islam Malaysia (USIM)	Arch
22	Kolej Universiti Teknologi Sarawak (KUTS)	Arch
23	Kolej Universiti Tunku Abdul Rahman (KUTAR)	Arch
24	City University	Arch
25	LimKokWing University of Creative Technology (LUCT)	Arch , C.E.
26	Universiti Tunku Abdul Rahman (UTAR)	Arch , C.E.

The purpose of the questionnaire was to determine, among academicians with expertise in Architecture and Civil Engineering, which pedagogical strategy would be most effective in incorporating Design Safety Knowledge into the Undergraduates programme. On a scale from 1 to 5 (strongly disagree to strongly agree), the responses to a questionnaire survey were scored according to the degree to which respondents agreed with the statement being posed. Cronbach's alpha was utilised in the examination of the questionnaires so that the internal consistency and intercorrelated sufficiency could be determined. The data were analysed using SPSS Software. The results of the reliability analysis that was carried out yielded a value of 0.811, which, in accordance with the general rule of Cronbach's alpha, is regarded as being satisfactory.

Research Findings

The respondents were asked what they believed to be the most effective strategy for integrating design safety education. A total of 85.9 percent of those who participated in the survey either agree or strongly agree that the Design Safety Body of Knowledge should be taught in architecture and civil engineering undergraduate programmes by being embedded in the current curriculum. On the other hand, as many as 81.2% of the respondents either agree or strongly disagree with the idea of incorporating the concept of Design Safety to be approached in a stand-alone subject.

According to the findings, the most effective way to include the topic of design safety in the designer curriculum is to incorporate it into the subjects that are already being taught, with an additional 3.7 percent of respondents agreeing to the proposal. In response to the question, one of the respondents suggested that the Design Safety Body of Knowledge "should be embedded in all current subjects for the students to understand the relationship between safety and design". Others are of the opinion that "Design safety requirements should be incorporated into existing design courses rather than as an additional or separate course." There is a small percentage of respondents who are concerned that the workload might become more challenging as a result of the introduction of additional topics. The respondent had the opinion that the students are currently overburdened with too many subjects; consequently, it is recommended that "Design Safety be integrated as part of the curricula, not one subject on its own.". According to the feedback, the embedded method will ease the burden of learning a new topic for students while also assisting them in better comprehending the connection between the topic of safety and every facet of a project.

As a result of the already overburdened curriculum, the participants in this study were in favour of both the standalone and embedded approaches. However, one of the respondents, in support of a stand-alone approach, stated that the design lecturers are not well trained to teach a safety subject due to a lack of knowledge on the topic. Therefore, if it is ingrained in their topics, it will not have a significant impact, and it will not be successful. This is supported by the findings of research conducted by Faida and Saidin (2013) on the challenges of integrating design safety education, where the lack of expertise in the subject matter was ranked as the greatest obstacle in the ranking.

This gives the impression that the academics are not very knowledgeable about the topic. According to Pellicer (2012), the lack of knowledge that some professors have regarding design safety and occupational safety and health might be a factor that slows down this process. To put it another way, the embedded method is impractical for academics, and it won't make much of an impression on industry experts. Another respondent, who stated that "design safety is paramount and should be included as a separate subject as well as embedded into the current curriculum," is in agreement with this statement as well. This is done to ensure that the students have a sufficient understanding of the concept to be able to perform it when they are working.

Stand-alone courses on design safety can focus on the basics to avoid overburdening students who are already overworked by their current courseloads. A stand-alone course on design safety may be limited to a basic introduction to Design Safety where it may directly impact the safety and health of persons involved during the construction process, product operation, and maintenance (Pellicer, 2012). This mandatory stand-alone subject is highly supported by (Cortes et. al., 2012; Pellicer, 2012; Zaneldin, 2014). Popov et al (2013) state that students majoring in Civil Engineering, Architecture and Building Construction in Virginia learn to design construction materials, tools, equipment and processes from a Design Safety

perspective. In situations where it has the potential to directly influence the safety and health of individuals involved in the construction process, product operation, and maintenance, the content of a stand-alone course on design safety may be limited to a basic introduction to design safety (Pellicer, 2012).

Conclusion

Despite the fact that the design safety implementation received positive feedback, the current level of the designer's knowledge needed to be improved (Che Ibrahim et. al. 2019). The incorporation of the Design for Safety Body of Knowledge (DfSBoK) into the Designer curriculum will provide future design professionals with a fundamental comprehension of the potential safety, health, and environmental risk issues that may be encountered in the course of their professional work. It is anticipated that requiring academics to incorporate design safety into their current module will only serve to slow down the development process even further.

Therefore this research recommends that the best approach in incorporating the Design for Safety Body of Knowledge (DfSBoK) to the undergraduates proceed with the stand-alone approach. This findings significantly contribute to the educational sector where it might be able to help in overcoming the obstacles that stand in the way of integrating design safety knowledge, namely for the architectural and civil engineering programmes respectively. This strategy has the potential to be utilised by both educational institutions and professional organisations in order to raise the level of awareness of the design safety body of knowledge among aspiring professionals.

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