Supporting Creativity: A Hands-On Industry Collaboration Case Study in Interior Architecture

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ABSTRACT
Various examples point to the advantages of using hands-on education approaches in interior architecture undergraduate education. The interdisciplinary nature of the field requires both theoretical knowledge, as well as practical knowledge be readily made available to students. The university has coupled with an industrial partner to identify and propose solutions to an actual market demand. This study aims to evaluate results of hands-on learning experiences in a product design course in interior architecture education. The study results are based on qualitative case-study research that took place in Modern Furniture Design (MFD) course. The mentioned course is a must course of Kirikkale University's 5.th term curriculum. The case-study presented here has been conducted in the course in the fall semester of 2019-2020 education year. Data has been collected using two sets of anonymous surveys; one from students, and the other from academic staff and industry representatives. The paper firstly discusses the concept of hands-on learning. Then the design factors that were used to define the borders of the product have been introduced. Finally the paper presents the method and moves on to discuss relevant findings of the study, in which the hands-on learning method has been applied to an actual market requirement.
Keywords: interior architecture education, hands-on learning, university-industry collaboration, product design

ÖZET
İç mimarlık lisans eğitiminde uygulamalı eğitim yaklaşımlarının kullanılmasının avantajlarına çeşitli araştırmalarda işaret edilmektedir. Alanın disiplinlerarası doğası, hem teorik bilginin hem de pratik bilginin öğrencilere kolayca sunulmasını gerektirir. Üniversite, gerçek bir pazar talebine çözümler belirlemek ve önermek için endüstriyel bir ortakla işbirliğine gitmiştir. Bu çalışma, iç mimarlık eğitimindeki bir ürün tasarımı dersinde uygulamalı öğrenme deneyimlerinin sonuçlarını değerlendirmeyi amaçlamaktadır. Çalışma sonuçları, Çağdaş Mobilya Tasarımı (ÇMT) dersinde yer alan nitel vaka çalışmasına dayanmaktadır. Söz konusu ders, Kırıkkale Üniversitesi 5. dönem müfredatının zorunlu bir dersidir. Burada sunulan örnek olay, 2019-2020 eğitim öğretim yılı güz döneminde derste yapılmıştır. Veriler biri öğrencilerden, diğeri ise akademik personel ve sektör temsilcilerinden olmak üzere, iki grup anonim anket kullanılarak toplanmıştır. Makalede öncelikle uygulamalı öğrenme kavramı tartışılmaktadır. Daha sonra ürünün sınırlarını belirlemek için kullanılan tasarım faktörleri tanıtılmıştır. Son olarak makale, yöntemi sunar ve uygulamalı öğrenme yönteminin gerçek bir pazar gereksinimine uygulandığı çalışmanın ilgili bulgularını tartışmaya devam eder.
Anahtar Kelimeler: iç mimarlık eğitimi, uygulamalı eğitim, akademi-endüstri işbirliği, ürün tasarımı

1. INTRODUCTION
There is increased demand to include real-world, hands-on experience in all fields of higher education (Hinson, D. 2007). Research shows that, hands-on design experiences elevate students' level of awareness while learning. Hands-on approaches to education in real scale design studies have started to be implemented in various universities from various countries (Erdman et. al. 2013). Review of literature suggests three factors that make a

significant contribution to this strategy's success. These factors are peer interaction through cooperative learning, object-mediated learning and embodied experience (Donna, S. 2010). Existing between the borders of human-scale design, product design is no exception, and in fact presents a unique opportunity for students to experience challenges and demands of industry while designing (Afacan, Y. 2014).

The rapidly changes in materials, finishes and design concepts undoubtedly affects the way interior architecture professionals design and operate. This rapid change in information also has a significant impact on the attributes of education that universities must provide. University education should train future-professionals so that they can approach design problems from different angles and achieve a synthesis of relevant information. Construction industry is discussing the issue of flexibility in manufacturing buildings. It is predicted that in the near future buildings will no longer be static and rigid structures but they will rather be adaptable spaces without undergoing major building operations. This view is supported with future projections that 3D printed buildings will be a reality within the next decade (CIDA, 2020, p.18). Future projections include issues such as minimal use of space and adaptability; topics both of which are referenced in lectures.

Interior architecture today, differentiates from architecture in the broad sense that it focuses more on creating individual experiences in built environments. This creation depends on various factors such as wellness, personal health issues, behavior and certain performance factors. Interior architects during their professional careers will -on many occasions- include spatial improvement commitments and will be held accountable by their customers if they fail to fulfill these promises. It is an emerging reality that interior architects need to learn how to acquire, analyse and interpret information while designing and to communicate with their customers on their design ideas. Interior architects who develop themselves more technically and socially will tend to make a difference among their fellow colleagues.

Industry-academia partnerships should be involved in the curricula of universities. Such endeavors benefit both industry and academia alike. During design activities, industry may encounter unique perspectives and ideas on a product they are developing or working on and also learn about latest developments occurring in their field through student research on the subject. From the students' point of view, they ought to gain valuable hands-on experience developing their projects and to better grasp the needs and priorities of the industry before their graduation.

Another topic of interest that is referred to in the paper is the exploration of gender differences. An extensive research conducted related with gender differences in terms of entrepreneurship has yielded important results. Dabic et. Al (2012) report that females are more reluctant to start their own businesses and although their psychological family support is more, they feel more tense, reluctant and concerned about entrepreneurship. According to a research conducted on gender based differences in stressors, it was reported that female students reported a higher perception of stressors in frustration, conflict, change and emotional reactions to these stressors. Male students on the other hand reported higher behavioral and cognitive reactions to stressors than female students (Hamaideh, 2010). However, review of studies show that there is yet much more to be done to uncover relationships between gender difference, student perception and learning outcomes.

This paper aims to discuss the results of an industry-academia partnership project. These results are obtained from a qualitative case-study research based on the proceedings of the Modern Furniture Design course. The paper has been structured to firstly discuss factors regarding hands-on educational experiences. The discussion continues to explore two design factors, namely minimal use of space and portability. Finally, the results of a hands-on experience with the design factors applied to the Modern Furniture Design course materials is evaluated as a field study.

2. ASPECTS OF HANDS-ON EDUCATION

The adaptation of hands-on learning into education can be traced back to as far as the 19th century. Pestalozzi pioneered the approach to using objects for teaching in elementary schools in America around 1860's. This development had been identified as The Object Teaching Revolution and had challenged the dominance of textbooks in education (Rillero, 1993). Active learning had been promoted by this development and this movement in education system eventually led to science experiments, field trips and school science collections. The National Education Association concluded that simple phenomena in nature be introduced into elementary school education and be pursued by means of experiments carried out by the students themselves. Direct contact of students to such materials and methods were identified to be of utmost importance (National Education Association, 1893. P.119).

The most basic definition of hands-on learning can be found in the works of Haury and Rillero (1994) that it is any educational experience that actively involves people in manipulating objects to gain knowledge or understanding. Implementing hands-on learning into university curricula has several benefits, some of these are (Knott, 2007):

- Causing students to rely on evidence instead of an authority (teacher, text, family, search engine). Most of the time students have no experience in decision-making because most of the time there is someone to tell them what to do and when to do it.
- Providing students with a similar set of experiences so that everyone's participation in the discussions are equally balanced, regardless of their socio-economic status.
- Forcing students to interpret obtained experiences rather than to memorize correct answers.
- Inducing the valuable message that the learner as well as the instructor can interpret data, and that various interpretations can often be reached. This situation resulting in richness of discussion and enabling further academic research.
- Encouraging questioning of observed phenomena and resulting data, due to the fact that students become familiar with the events and variables involved in the process.
- Promoting cause and effect reasoning for students.
- Finally, reducing dependence to authorities so that further studies be carried on by themselves.

The term "hands-on" refers to activities consistent with several educational philosophies. However, three important aspects emerge when dealing with the subject (Klahr et. al., 2007). Firstly, whether the learner is dealing with actual physical or virtual materials is a major topic. Nowadays computers are able to provide a unique opportunity such that the computer generated virtual materials may result in learners' avoiding potentially harmful situations of hands-on applications. Secondly, whether the type of knowledge being taught to learners is domain-general or domain-specific. Domain-general knowledge is often referred to as 'process skill' where information exceeds any specific science branch. Thus revealing information that can lead to general conclusions. Domain-specific knowledge on the other hand, is specified knowledge regarding a specific science domain like physics, chemistry etc. Thirdly, on the learning scale that ranges from discovery learning to direct instruction, where exactly does the pedagogy associated with hands-on learning lies. A research conducted by Hmelto et. al. (2000) compared the means of knowledge gain in two different situations where the first case was from conventional lectures and standard text books and the second was from a hands-on discovery context with physical materials. Results showed that the students in the design condition had learned more.

3. DESIGN FACTORS

The general use of the term of product design includes planning and creating three dimensional objects while keeping an affirmative use of user-interaction in the core of all these activities. The design process concentrates on creating solutions for people, physical items and abstract systems. The key term in all design activities is to identify a void in the satisfaction of demands and to introduce a proper solution in the form of a physical object or even a user interface in some situations. Designing a product is seldomly related with decorating or introducing useless ornamentations on an existing product. Rather as professionals in the field like to define a well-designed object as leaving out every excess item so that only the essence of the item fulfilling a specific task remains. True beauty in design emerges from functional objects having refined simplicity.

Product design approaches every design problem with a similar comprehensive and systematic approach. Aspects of design problems are namely: who the user group is (gender, age, obstacles in life etc.); what are the problems they encounter; area of usage (indoor, outdoor or other specific areas); what are existing solutions to this specific design problem; what demand is the product going to satisfy (what will this designs' contribution is going to be). Color, shape, function are all but means of obtaining a satisfactory design that in return helps to enrich peoples' lives and experiences. This aspect clearly highlights the fact that whole design activities are situated around people and that design activities are user-centered.

Each design output is the sum of all its design variables. Each design accommodates different values of variables such as user groups, areas of use and whether they are to be used when in mobility or not. To all those accustomed to design, each value of a variable has impacts on various other aspects of the final designed object. For instance whether an item is going to be used outdoors or indoors results in selections regarding materials, color, folding mechanisms, finish details so on. It is equally important to address that the selection of design variables are as important as the design output itself. Among many variables relevant to principles of design, two major design factors that were potentially predicted to have the most importance to the output design have been determined as *minimal use of space* and *portability*. How these two variables were addressed to, determined the success of the final design output at the final evaluation done at the end of the term by academics and qualified specialists.

Under the topic minimal use of space, emerging sub-topics can be identified as foldable objects and compact objects. In most cases, an object that can be folded can result in it's diminishing in size however this does not always result in the object's compactness. The term compact is referred to the rate that objects can diminish in size via hinges, connections or other joint mechanisms. This concept of compactness is crucial especially for campers and other outdoor activists.

The topic of portability has both implications to outdoor use and an object being able to be transported. In the course definition, the features of portability have been defined as outdoor items that will be opened and used then closed and transported. During the transportation of the object, the object would be equipped with handles, straps or the design of the seating textile be in such a manner that it can be used to encase and carry the object when being transported.

4. MODERN FURNITURE DESIGN (MFD) COURSE

Modern Furniture Design (MFD) course is an obligatory course for third year students enrolled in Interior Architecture and Environmental Design Department at Kirikkale University in Turkey. A total of 51 students took the course, but 39 of them were able to fulfill the requirements of the course and took part in the survey. The two major aims of the MFD course can be outlined as, firstly to encourage students to produce original design outputs to current design problems and secondly, to encourage students to engage with local producers to have their design mock-ups produced. This is the third course since 2017, where the outputs of this course have led to several national publications and a workshop in another fellow university. The topic of the design problem has been specified differently for each years' course, however only two aims of the course that have been defined above, have been preserved through the whole duration. The first two years of the course have been reserved to upper-cycling of waste materials in order to create awareness to global waste issues. The content of the class in 2019, has followed a different path due to the fact that the year 2019s' design problem was defined in accordance to a request initiating from the industrial partner, Kervanci AS -the manufacturer partner specialized in producing outdoor portable furniture. The design problem was formulated after analysis of the market, problems related with existing products have been examined and the need to differentiate products have been discussed.

The design problem was defined in coordination with Kervanci AS requesting design assistance for a portable and compact camp chair that would help to differentiate them from other rivals in the market. This paper analyses aims and methods of design implemented in the MFD course and evaluates them against the views and expectations of students, academic staff and the industrial partner involved in this year's design project.
Even though there is sufficient literature citing the advantages of academia-industry collaboration for projects in product design classes, there is a lack of quantitative analysis and data on its gains. This study aims to quantitatively assess benefits gained and challenges experienced by incorporating a real project requirement from industry with design class requirements. Students were held responsible for creating and delivering their design outputs manufactured in various local workshops, together with a 2D presentation sheet summarizing research, technical drawings and usage data. The study presents both the students' perspective as well as observations and comments of industry representatives.

5. METHOD

Participants were 39 students from a total of 51 students who took the course. Among the 39 students who were able to fulfill the requirements of the course and took part in the survey, 30 of the students were female and 9 of them consisted of male students. All students were enrolled in the Department of Interior Architecture and Environmental Design at Kirikkale University in Turkey. The MFD course is a must course in the 5^{th} semester of the department's curriculum. The total duration of the project was 8 weeks which nearly equals to a half-semester. The total duration was spent on research on similar products, a presentation made by the firm representative, project critiques and finally having the mock-up produced by local craftsmen.

Data Collection

An anonymous survey consisting of 23 questions was used to collect data. Participants were provided with a description of the study with its scope and intent and were asked to sign an informed consent statement. Participants were also asked to declare whether they were 18 years or older before beginning the survey. No financial support or incentive was provided to participants for participating in or completing the survey.

A 5-point Likert scale was used for the majority of questions. For others, either students were asked to input values themselves, such as for gender and age or were asked to pick one or more options, such as for reporting factors that affect the quality of their output.

Data Analysis

Descriptive statistics were used in analyzing research results. Descriptive statistics use certain coefficients in order to summarize a given data set, these can either represent the entire or a sample of a population. Measures of central tendency such as mean, median, and mode are calculated for results. To define the basic terms: *Mean* or the *Average*, is found by adding the figures of a data set and then dividing the sum by the number of

figures thus finding the mathematical average of the data set. *Median* is the figure situated in the middle of the data set, and the *Mode* of a data set is the value that appears most often. Median of a data set is a figure that separates the higher figures from the lower ones. The aim of using descriptive statistics is to restructure not so apparent relations within a large data set into easily definable small descriptions (www.investopedia.com).
In statistics correlation coefficients are used to measure the strength of a relationship between two sets of variables. Pearson Product Moment Correlation is the method also referred to as Pearson's correlation coefficient or Pearson's *R*, is commonly used in linear regression. Results found are within a range of -1 to 1, where positive values indicate a positive correlation and negative values indicate inverse correlation among the factors analyzed. A value of 0 indicates that no correlation exists (www.statisticshowto.datasciencecentral.com).

Results of inquiries were individually recorded in a spreadsheet for every student to enable correlation analysis. Spread of data were analyzed by calculating the standard deviation and coefficient of variation, which is a standardized representation of the dispersion.

6. RESULTS AND DISCUSSION

Of the 39 participants that fully completed the survey, the percentage of males and females were 77% and 23% respectively. Results for questions that employed a Likert-scale are provided in Table 1.

Table 1. Descriptive statistical results of select questions answered by students. For central tendency, a value of '1' indicates displeasure or insufficiency, and '5' indicates satisfaction or sufficiency with respect to the question.

Questions (How do you evaluate …)	Mean	Median	Mode	Standard Deviation	Coefficient of Variation (%)
The planning of the course in line with understanding market demands?	3.2	3	3	0.97	31
The time allocated for the project?	2.3	2	2	0.88	39
The design of the course in its execution to measure weekly progress?	3.3	3	4	1.10	33
Your level of research at the end of the project?	3.3	3	3	0.65	20
The aesthetic level of the design you put forward at the end of the project?	3.0	3	3	0.89	30
The technical level of the design you put forward at the end of the project?	3.1	3	3	0.93	30
Your understanding of market needs at the end of the project?	3.3	3	3	0.79	24
The mock-up quality of the design that you produced at the end of the project?	2.9	3	3	0.85	29
The presentation content of your design at the end of the project?	3.2	3	3	0.96	30
The improvement in your presentation abilities at the end of the project?	3.4	3	3	0.67	20
Your time management skills during the project?	3.0	3	3	0.86	29
The improvement in your time management skills by the end of the project?	3.1	3	3	0.89	29
Your design capacity at the end of the project?	3.4	3	3	0.96	29
The improvement in your design preparation ability at the end of the project?	3.3	3	3	0.73	22
The improvement in your ability to do business in industry at the end of the project?	2.7	3	3	0.94	34
The experience you gained as part of this course having done business with industry?	3.4	3	3	0.85	25

In general, mean results seem to be centered around the value 3. However, there are variations in results related to time management, their presentation skills, improvement in overall design capacity and practical industry experience that are noteworthy.

Students noted that the allotted time for the project was insufficient although they were less critical of their own time management skills. However, they did favor the approach to keep track of progress on a weekly basis.

Research on the subject before progressing to further steps of design was required as part of the course. This fact reflects on the survey responses, where students see their research on the subject as sufficient. The mean of students' responses did not indicate direction on the technical and aesthetic level of their final design or their quality of the mock-up they put forth at the end of the semester and these three questions exhibited similar variation in responses.

Presentation skills and development in that area has been rated favorably by students. Especially improvement in presentation skills was one of the highly rated questions and had one of the lowest variations among responses. A factor that may have contributed to this result is that students were not only asked to present their design, but they were required to present to an audience consisting of professionals from industry, the course instructor and fellow colleagues. Such diversity may have contributed to better preparation and thus improved satisfaction with respect to presentation.

Overall, one of the most highly rated questions were improvement in students' design capacity by the end of the semester, facilitated via the hands-on project. This is encouraging, as despite the problems faced and challenges experienced in their first exposure to a real industry project with high output expectations, they self-report gains in their design abilities. This conclusion is strengthened by the last question related to the experience gained due to having done business with the industry, which exhibited a similar mean value on the positive side. Therefore, students appear to have appreciated the experience to work on a real project from industry to further their education. On the other hand, some students may have been intimidated by the experience, and difficulties experienced while trying to produce the mock-up designs as indicated by their response to improvement in their ability to do business in industry.

A separate question inquired about the challenges that students had faced during the project, the results were limited to a maximum of three options. Among the major reported problems, 64% of students chose "Craftsmen attempting to impose their own views on me", 51% of students chose "not being able to communicate on the design drawings with the craftsmen", and 46% chose "Project demands not being taken seriously by craftsmen". Challenges due to delays in due dates or variations in cost prices were not reported significantly. Another question inquired on factors affecting the quality of the mock-up design and results seem to build on what was reported above as 79% of students chose "not able to find a craftsman to produce the mock-up design".

Responses to questions with similar scope were analyzed using correlation analysis. A strong direct correlation was found between self-reported improvement in students' ability to do business in industry by the end of the project and experience gained as part of this course having done business with industry, with a Pearson coefficient of 0.53. There was also strong direct correlation among experience gained and understanding market needs with a coefficient of 0.50. Results for two questions assessing presentation content and improvement in presentation abilities were also closely correlated, indicating that students who are satisfied with the contents of the semester final presentation, feel that they have improved their presentation skills.

Interestingly, even though the question on time allocated for the project received the lowest score in the survey, students do not appear to be consistent when evaluating time, time management, and improvement in their time management skills. There appears to be at best a weak correlation among responses to these three questions. Responses to questions on their time management skills, and improvement in their time management skills exhibit a Pearson coefficient of 0.00, indicating no correlation. Although the underlying reason is unclear, some students may be attributing shortcomings in their project to a perceived lack of time as compared to their time management skills. However, there was not a consistent response indicated by the correlation coefficients.

Gender differences

Gender differences in responses were analyzed and differences were observed in the results of some questions for female students. These observations are based on results of correlation analysis. Research conducted related to gender differences in education suggests (Witherspoon, et. al., 2019, p:199) that women pursue careers paying less and in lower status positions than men relative to their initial medical school intentions. Variations in behavior between genders has been a common issue.

Inverse correlations were found for planning of the course to understand market demands and improvements in time management skills. While it is not exactly clear what the underlying factor may be, these results perhaps may be attributed to female students taking the class with higher prior presentation skills or knowledge on market demands. Furthermore, there is also an inverse correlation for presentation content of their designs, where female students were less satisfied with their final presentation content compared to male students. When asked whether they would prefer to work in groups or individually, 63% of female students favored working in groups; whereas 67% of male students preferred to work individually. While overarching statements cannot be made from these results, these two responses may be due to female students hesitating when dealing with craftsmen on their own, as compared to male students. This conclusion was supported by the instructor’s observations during the semester.

Direct correlation was found for higher ratings of students’ self-rated design abilities for female students with a Pearson coefficient of 0.37. There is consistency here as female students also rated the aesthetic level and technical level of their final designs at the end of the semester, with Pearson coefficients of 0.21 and 0.22.

Industry Perspective

A separate survey was conducted to 6 participants from industry who evaluated the projects at the end of the semester, and results are presented in Table 2.

Table 2. Descriptive statistical results of select questions answered by project evaluators from industry. For central tendency, a value of ‘1’ indicate displeasure or insufficiency, and ‘5’ indicate satisfaction or sufficiency with respect to the question.

Questions (How do you evaluate ...)	Mean	Median	Mode	Standard Deviation	Coefficient of Variation (%)
The planning of the course in line with understanding of market demands?	4.3	4	4	0.52	12
The level of research on the subject at the end of the project?	3.2	3	3	0.75	24
The aesthetic level of the design put forward at the end of the project?	2.8	3	3	0.75	27
The technical level of the design put forward at the end of the project?	2.5	2,5	3	0.55	22
Students' understanding of market needs at the end of the project?	2.7	3	3	0.52	19
The mock-up quality of the design put forward at the end of the project?	2.5	2,5	3	1.05	42
The presentation content of the design put forward at the end of the project?	3.2	3,5	4	0.98	31

Students' time management skills at the end of the project?	2.7	3	3	1.03	39
Students' design capacities at the end of the project?	3.0	3	3	0.63	21
The overall status of students to work in industry?	2.5	2.5	2	0.55	22

Professionals from industry rated the design of the course highly in terms of understanding and conveying market needs to students. The mean rating of 4.3 with a coefficient of variation of 12% indicates the consistency in that respect. However, the mean of students' understanding of market needs was rated low, below the median and closer to unsatisfactory. These results indicate that overall, projects were not able to fully address market needs. Furthermore, professionals from industry rated the aesthetic and technical level of presented design output lower than students. Overall, industry representatives expressed doubt whether students were ready to proceed in industry, based on their project performances.

Final Products

Figure 1. Successful examples of student works (Source: Personal Archive, 2020)

In Figure 1 are some examples of student projects among the total of 39 submitted projects. These three have been evaluated as being among the most successful ideas by a jury composed of academicians and experts from the industrial counterpart. Each of these projects satisfy design criteria of being portable, being foldable and have the highest rate of becoming a compact object suitable for being carried. These criteria have been discussed previously in the design factors part of this essay.

Portability and outdoor use concepts have manifested themselves in the material selection of the designs. Each project proposal is a mixture aluminum profiles, tubes, textiles and plastic joint pieces. Finishes regarding metal coatings or textile color or patterns have been overlooked, as the true value of these designs resided in the mechanic solutions each introduced to justify the design factors.

The results of the course have been satisfying according to the views of all three parties namely academicians, industrial counterpart and the students. We the academicians are satisfied in the termination of the project within the rather tight timeframe with satisfying results. The industrial counterpart has benefitted from a wide range of design views most of which were equivalents of -if not better than- existing products in the market. They have expressed their interest in continuing our partnership for new products in the future. It is my belief that the party benefitting the most from this venture has been our students. Some have produced ideas that are well worthy of intellectual design rights. The three students whose projects have been referred to in Figure 1 have had a contact established with the industry before graduation, where their project proposals might be produced in the future. The rest of the students have had a product mock-up produced and have gained an important experience in an academia-industry collaboration project of which the benefits will become more apparent in their near-future work application phase of their lives.

7. CONCLUSION

Interior architecture as a profession is human-oriented in a sense that all that is done has a fundamental effect on the way humans live. Interior architecture profession is interdisciplinary so that it serves as a crucial link between people who seek to live in distinctive spaces and the skilled craftsmen who are able to attribute to the building of such spaces. The interior architect is trained so that he/she can create and convey unique designs to patrons and define a status of living for them. The interior architect however must be skilled adequately in order to converse designs with the craftsmen. In order to communicate with the craftsmen, the designer ought to be able to technically produce relevant drawings in the correct manner so that they can be produced correctly the way they are drawn.

Academic education can not disregard the task that interior architects fulfill in construction industry and equip students with technical data as well as improving their creative skills. With the use of hands-on learning methods, it is of utmost importance that students work with real materials and solve real design problems. It has been an enlightening experience that the MFD course has been conducted so as to let students gain experience from the actual industry in terms of the design process and its resulting manufacture processes.

The aim of this study has been contributing to reveal the gains of academia and industry collaboration. Student responses to questions revealed new results open for debate as discussed thoroughly in the Results and Discussion part of the study. In terms of gender differences, responses regarding the proposal of creating study groups was accepted positively by female students but rejected strongly by male students.

Another important aspect of the study has been to evaluate the opinions of industry representatives. In summary, these representatives have expressed positive opinions regarding benefits of similar hands-on projects helping students to understand industry needs. Different views between academic personnel and industry representatives were among findings in the sense of creativity and production techniques. Innovative ideas were regarded highly by academicians whereas projects having the capacity of being produced easily were regarded highly by industry representatives.

8. REFERENCES

Afacan, Y. (2014). Introducing sustainability to interior design students through industry collaboration. *International Journal of Sustainability in Higher Education*.

CIDA, Future Scan 2019. (2019). Retrieved on March 19, 2020, from https://www.accredit-id.org/futurescan

Dabic, M., Daim, T., Bayraktaroglu, E., Novak, I., & Basic, M. (2012). Exploring gender differences in attitudes of university students towards entrepreneurship. *International Journal of Gender and Entrepreneurship*.

Erdman, J., Weddle, R., Mical, T., Poss, J. S., Hinders, K., McCown, K., & Taylor, C. (2002). Designing/building/learning. *Journal of Architectural Education*, *55*(3), 174-179.

Hamaideh, S. H. (2012). Gender differences in stressors and reactions to stressors among Jordanian university students. *International Journal of Social Psychiatry*, *58*(1), 26-33.

Haury, D. L., & Rillero, P. (1994). Perspectives of Hands-On Science Teaching.

Hinson, D. (2007). Design as research: Learning from doing in the design-build studio. *Journal of Architectural Education*, *61*(1), 23-26.

Hmelo, C.E., Holton, D.L., & Kolodner, J.L. (2000). Designing to learn about complex systems. *Journal of the Learning Sciences*, 9, 47–298.

https://www.investopedia.com/terms/d/descriptive_statistics.asp Retrieved on March 15, 2020

https://www.statisticshowto.datasciencecentral.com/probability-and-statistics/correlation-coefficient-formula/ Retrieved on March 21, 2020

Klahr, D., Triona, L. M., & Williams, C. (2007). Hands on what? The relative effectiveness of physical versus virtual materials in an engineering design project by middle school children. *Journal of Research in Science teaching*, *44*(1), 183-203.

Knott, R. (2007). Science Curriculum Improvement Study 3. *University of California, Berkeley*.

National Education Association. (1893). *Report of the committee of ten of the committee on secondary school studies*. Washington, DC: US Government Printing Office.

Rillero, P. (1993). The enlightenment revolution: A historical study of positive change through science teacher education. *Journal of Science Teacher Education*, 4(2), 37-43.

Satterthwait, D. (2010). Why are'hands-on'science activities so effective for student learning? *Teaching Science: The Journal of the Australian Science Teachers Association*, *56*(2).

Witherspoon, E. B., Vincent-Ruz, P., & Schunn, C. D. (2019). When Making the Grade Isn’t Enough: The Gendered Nature of Premed Science Course Attrition. Educational Researcher, 48(4), 193–204. https://doi.org/10.3102/0013189X19840331