

ENHANCING INDUSTRIAL DESIGN EDUCATION THROUGH STUDIO-LECTURE COLLABORATION

A STUDY OF INTEGRATING A HUMAN FACTORS COURSE INTO A STUDIO PROJECT

BYUNGSOO KIM AND HERNAN GREGORIO
KANSAS STATE UNIVERSITY

PAPER ABSTRACT: This study explores the integration of human factors coursework into an Industrial Design Studio project to assess the potential opportunities, benefits, and drawbacks of such collaboration in design education. The instructors of both courses collaborated to incorporate knowledge of anthropometrics, ergonomics, and usability into the studio project. A total of 14 Industrial Design students participated in the project, which focused on the design of a hand tool with an emphasis on human interaction and ergonomics. At the end of the eight-week project, a survey was conducted to evaluate students' learning experiences. The results of the study suggest that this integration of lecture and studio coursework can enhance students' understanding of the design process and improve their design solutions. The paper presents the results of the study and discusses the potential for future collaborations between studio and human factors lecture courses in industrial design education.

Keywords: Industrial Design, Design Education, Human Factors, Studio Project, Collaboration in Education.

1. INTRODUCTION

In design education, it is important to not only learn theoretical knowledge but also practice the application of learned knowledge in design projects. Hence, most Industrial Design (ID) programs teach and train their students to be professional designers by mainly applying two teaching models, Studio-based learning (SBL) and Lectures. SBL is an effective and well-utilized methodology found in design studios to tackle on the given design challenges to have real-world-like working experience (Cennamo, et al., 2011). On the other hand, the main purpose of lecture courses is to build foundational and advanced concepts, principles, and theoretical knowledge that forms the basis of industrial design. Although lecture-based courses have several benefits, such as laying a strong foundation of knowledge and providing exposure to diverse perspectives, some scholars argue that this traditional method of teaching is dull and may become outdated (Bajak, 2014; Bates, 2014). Furthermore, since lecture courses often focus on theoretical knowledge, this can lead to a gap between what students learn in the classroom and their ability to apply that knowledge in a practical setting.

In response to this challenge, design education has witnessed an emerging trend of imparting theoretical knowledge in a studio-style setting (Nabih, 2010). This approach has been beneficial,

especially in linking theoretical knowledge to the practical design process. However, teaching theoretical knowledge during studio time can be challenging since one of the primary objectives of the studio is to produce high-quality design outcomes, and instructors cannot allocate sufficient time to both theory instruction and producing excellent design proposals. Collaborative teaching has been a method to support effective learning for students. While successful teaching collaboration is only possible when two or more instructors are committed and receive support from their schools (Härkki et al, 2021), it will maximize students' learning and the application of theoretical knowledge to design practice. While there are studies about teaching collaboration in industrial design education including co-teaching and co-design process (Saurus, 2012), cross-college collaboration, and co-teaching (Ollis, 2005), there are not many studies documenting the students' experience with studio-lecture collaboration.

This study explores the impact of two ID instructors' collaboration to enhance ID students' learning experience through the integration of human factors coursework into an Industrial Design Studio project. The purpose of this study is to assess the potential opportunities, benefits, and drawbacks of such collaboration in design education.

2. MATERIALS & METHODS

The study was conducted over an eight-week period as part of the third-year Industrial Design program at the authors' university. During this period, the studio instructor collaborated with the human factors course instructor to integrate the principles of anthropometrics, ergonomics, and usability studies into the studio project. The integration of the timing and the content of the human factors course lectures and assignments were overall aligned with the studio project, with the aim of applying students' learned knowledge, specifically in the areas of ergonomics and usability, from the lectures to the studio project.

2.1. PROJECT OVERVIEW AND MATERIALS

The focus of the studio project was to create a refillable container and tool for professional detailers, with emphasis on human factors, utilizing the Double diamond design process with its four main steps: Discover, Define, Develop, and Deliver (Design Council, 2007). The topics of the human factors lecture imparted for the studio project include the following themes: 1) observation/muscle fatigue evaluation, 2) actionable statement development, 3) concept idea exploration, 4) prototyping, and 5) usability testing. The lecture content was strategically synchronized with the studio project timeline. See Figure 1 for the collaboration timeline overview.

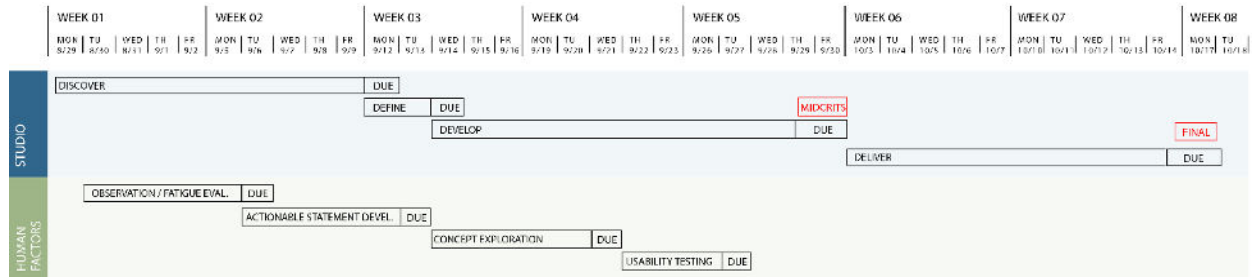


Figure 1. Overview of Collaboration Timeline.

The project started in the discovery phase (Week 1-2), where students conducted online research, and analyzed the detailing profession, users, context, and existing market offerings. In addition, they were assigned to locate professional detailers in the area and conduct ethnographic analysis through direct observation and interviews with them, aimed at identifying real user needs, pain points, and potential design opportunities. During the discovery phase, students were taught in human factors class how to conduct observation and fatigue evaluation. Students also learned observation techniques, including creating observation sheets and using the think-aloud strategy. They then immersed themselves in the cleaning, washing, and polishing process through an experiential learning experience (Kolb, 1984). Students observed, analyzed, and documented their movements, posture, and physical pain points. In the define phase (Week 3), students were taught how to develop actionable statements based on their learnings from the human factors class. Moving further, they created a project brief that included a user persona, design opportunities, and human factors considerations. The development phase (Week 3-5) involved multiple design iterations through sketches and prototypes that tested all aspects of the design, including form, function, semantics, ergonomics, anthropometrics, color, materials, and finishes. During the process, the human factors class provided instruction on designing the handle component of car detailing products, as well as conducting usability studies based on the prototypes. After several prototypes and tests, students developed the best ideas during the development and delivery phases, creating a design that performs well not only in terms of form, aesthetics, and function but with a strong consideration of human factors. The human factors course during this phase expanded its coverage to include other topics such as visual perception and inferences.

2.2. SURVEY DESIGN

The survey administered to the students aimed to gather both quantitative and qualitative feedback on their experiences and perceptions of the studio collaboration project. The survey included several questions that evaluated the project's various phases and the students' preparedness for the activity. The first question asked students to rate their overall experience of the project, selecting from a scale of very good, good, so-so, could be better, and bad. The second question was open-ended, asking students to identify the positive aspects of the project and provide suggestions for improvement while evaluating each phase, including observation and fatigue evaluation, actionable statement development, idea exploration, prototyping, and usability testing. The third question inquired about students' preparedness

for the activity, with response options ranging from very prepared to not prepared for each task. The final question focused on the amount of guidance provided during the project and asked students to rate it from very good, good, neither good nor bad, more guidance would have been helpful, and very little/no guidance was evaluated for each task.

At the end of the eight-week project, an online survey was conducted to evaluate students' learning experiences. The survey was anonymous and participation in the survey was voluntary. There was no compensation for completing the survey. Before the survey, the students were notified that there will be no disadvantages to not participating. The study plan and the survey questions were reviewed and approved by Kansas State University Institutional Review Boards (Protocol number: 11411).

2.3. PARTICIPANTS

The participants were 3rd year ID students who took both the studio and human factors courses in the 2022 Fall at Kansas State University. While some of them have learned the general concept of human factors from their previous studios (depending on the instructors), all of them did not have formal training in human factors and ergonomics as part of their ID education.

3. RESULTS

14 out of 15 students completed the survey. The survey yielded valuable findings as both quantitative results allowed the authors to identify successful phases and areas requiring improvements, while qualitative responses provided a deeper understanding of the implications through participants' written comments. This paper presents the key themes that emerged from the results of the survey as follows: 1) overall studio collaboration experience, 2) level of preparedness, and 3) amount of guidance. Through the analysis of quantitative/qualitative data gathered from the survey, this paper aims to shed light on the benefits and limitations of this approach to design education.

3.1. OVERALL STUDIO COLLABORATION EXPERIENCE

The participants were asked to evaluate their overall impressions of the studio collaboration project using a Likert scale. Among the participants, more than half of them (n=9 out of 14, 64.29%) reported a positive experience, combining "very good" and "good". Based on the students' comments, they appreciated the opportunity to apply ergonomics principles in their design and found it helpful that both classes were focused on the same type of project. Overall, the project was considered successful in enhancing their understanding of the application of human factors-related knowledge in design. Some students expressed the desire to work on more projects like this collaboration throughout the semester.

4 students reported their experience as so-so (28.57%), and 1 student (7.14%) expressed that the experience could have been better. Based on the comments students made, some of them identified issues with the alignment of project timelines between the two classes, which created confusion, as the Human Factors class taught the studio project-related knowledge one step earlier than the Studio class.

Students felt that coordinating the timing better would improve collaboration. The primary cause of the misalignment between project timelines, along with suggestions on how to enhance the alignment are presented under "Collaboration Challenges and Improving Alignment between Courses" and "Aligning Lecture Content with Studio Project" in the "4. Discussion" section.

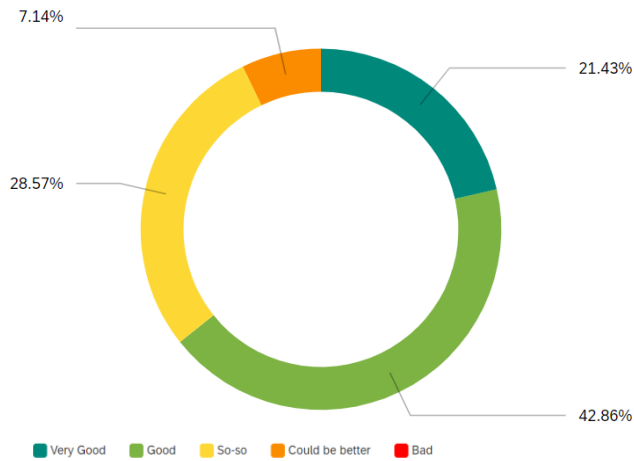


Figure 1. Overall studio collaboration experience.

3.2. LEVEL OF PREPAREDNESS

The participants were asked to assess their level of readiness for the five designated activities. In general, most of the participants reported a sense of preparedness for both actionable statement development and prototyping, with no individual expressing a need for additional preparation in these domains. Notwithstanding, some students expressed a perceived lack of preparedness for idea exploration (n=2), observation (n=1), and usability testing (n=1), suggesting that these tasks may require further preparatory efforts. As students perceived the idea exploration as the least prepared phase, the detailed interpretation and suggestions for improving the preparation of the phase are presented under the subsection titled "Improving Idea Exploration Phase Preparation and Guidance for Students" in the "4. Discussion" section.

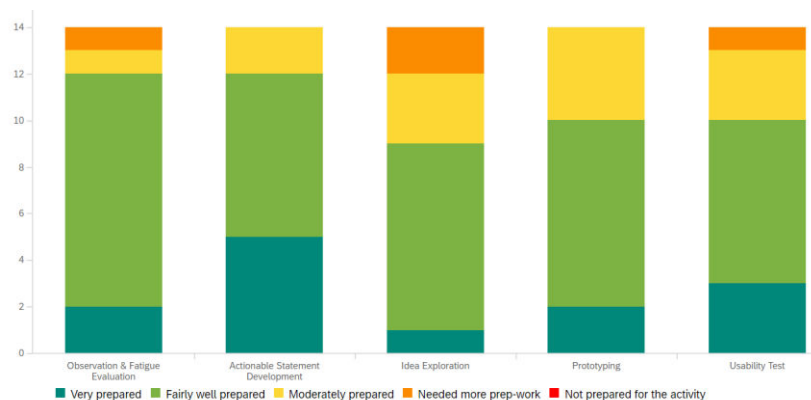


Figure 2. Level of Preparedness.

3.3. AMOUNT OF GUIDANCE

The participants were asked to assess the amount of guidance for the project for the five designated activities. In general, at least more than nine participants (64.29%) reported the amount of guidance for every task was very good or good.

Regarding the Observation and Fatigue Evaluation, 11 out of 14 students (78.57%) reported that the amount of guidance was either good or very good. Students appreciated the opportunity to apply their learning in a practical setting and found the experience helpful in understanding the factors being designed for and the issues raised during interviews. However, 2 students (7.14%) felt that more guidance would have been helpful, with 1 student specifically suggesting that more direction on how to carry out the observation/fatigue evaluation would have been better.

For actionable statement development, 13 out of 14 students (92.86%) reported that the amount of guidance was either good or very good. One student commented that they found the work on actionable statements particularly helpful, as it allowed them to better understand how a project brief should look. However, one student (7.14%) felt that the amount of time spent on this activity was excessive and that it was not entirely necessary to practice revising the actionable statement to such an extent.

For idea exploration, 10 out of 14 students (71.43%) found the amount of guidance to be good or very good. However, 2 students felt that they would have benefitted from more guidance. One student mentioned the issue of alignment between the studio project and human factors class assignments, stating that the timing of the idea exploration during the lecture course did not line up well with the studio project. Another student mentioned that more help with ideation would have been helpful.

For prototyping, 12 out of 14 students (85.71%) reported the amount of guidance was either good or very good. On the other hand, one student (7.14%) felt that more guidance would have been helpful, specifically in terms of time alignment with the studio project. The student mentioned that while the development part of prototyping went well, it was much more independent from the studio project and the overall timeline did not line up as well. Another student mentioned that while prototyping was good, it was very early in terms of the studio aspect.

For the usability test, 9 out of 14 students (64.29%) reported the amount of guidance was either good or very good. Students mentioned that getting feedback from peers and testing the handle was very helpful to improve the design. The usability test was also reported to be at a good time for the development of the final studio design. However, some participants felt that they needed more guidance for the usability test task. One participant suggested that it might be more helpful if each group member was more aware of their role in the process, such as the person filming and the person doing the activity, and when they would switch.

The suggestions for improving guidance in the usability test phase, which the largest number of students felt was insufficient compared to other phases, can be found under “Improving Usability Study Guidance and Support for Students” in the "4. Discussion" section.

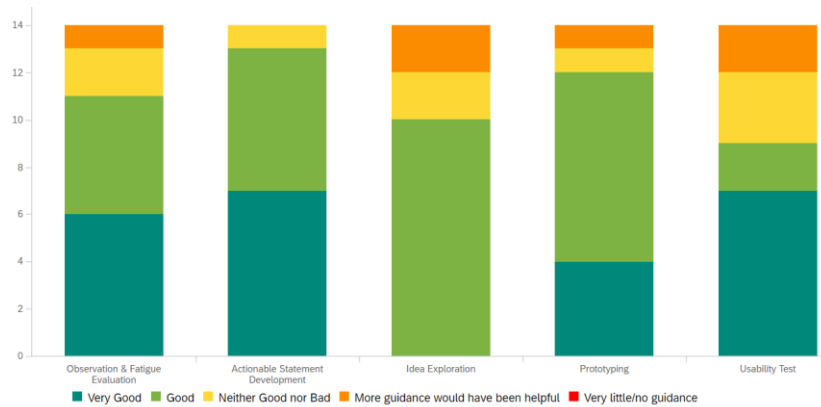


Figure 3. Amount of guidance.

4. DISCUSSION

The discussion section begins by reflecting on the successful aspects of the project and the positive impact it had on students through the collaboration between studio and lecture courses, including the following topics: 1) enhancing user-centered design in the studio and 2) project selection for optimal human factors and studio learning. This section also addresses the identified areas for improvement based on survey results and the authors' observations during the project, covering the following aspects: 1) collaboration challenges and improving the alignment between courses, 2) aligning lecture content with studio project, 3) improving idea exploration phase preparation and guidance for students, and 4) improving usability study guidance and support for students. Furthermore, the section concludes by presenting recommendations for future studies aimed at implementing improvements.

Enhancing User-Centered Design in the Studio: As presented in the survey results, the project has been deemed a success as it greatly enhanced their comprehension of utilizing human factors-related knowledge in the realm of design. This collaborative effort provided students with several advantages in their studio work. Firstly, it enabled them to place a greater emphasis on understanding and empathizing with the user during the discovery phase, highlighting the importance of human factors when analyzing and comprehending user needs. As a result, they were able to develop more thorough and concise project briefs that provided a deeper understanding of the user, context, and activities. Second, students were able to iterate and compare their design ideas while keeping human factors in mind during the development phase, resulting in designs that were aesthetically pleasing, functional, and ergonomic. Lastly, during the delivery phase, students designed their posters and communication strategy with a strong emphasis on the ergonomics, human posture, and usability of the products.

Project Selection for Optimal Human Factors and Studio Learning: In the current study, the topic of designing a hand tool was deemed appropriate for students to apply their learned knowledge from the human factors class, emphasizing the importance of selecting appropriate topics for students' portfolio development and human factors-related learning. The next collaboration should also consider the ideal project topic beneficial for students to maximize their learning in both courses. The potential projects for the collaboration need to include physical aspects that users frequently interact with their hands and currently pose challenges for users, such as muscle fatigue due to using the products for an extensive amount of time and/or performing tasks in a non-neutral posture. By selecting projects based on these criteria, students will be able to learn the key content of human factors and ergonomics-related knowledge from the human factors class and practice and apply this knowledge in their studio projects. This will enable students to develop designs that not only meet the functional and aesthetic needs of users but also consider their comfort, safety, and well-being.

Collaboration Challenges and Improving Alignment between Courses: There were difficulties in terms of constant sharing of progress between the two courses. Since the studio project design process may change according to different variables as the design process evolves, it can be challenging to keep the lecture instructor informed about the current state of the project. This is especially true if the lecture instructor is not physically present during the studio class. To address these challenges, it may be helpful to establish a communication protocol that allows for regular updates between the two courses. For example, students could be required to provide regular updates on their project progress and how it relates to the lecture. Additionally, it may be helpful to establish a shared platform for collaboration, such as an online forum or shared project management tool, that allows for easy sharing of information and updates between the courses. In terms of synchronizing the lecture content with the studio project, it may be helpful to establish a more flexible curriculum that allows for adjustments based on the progress of the studio project. For example, the lecture content could be structured in a modular format that allows for certain topics to be covered at different points in the semester, depending on the needs of the studio project. Additionally, it may be helpful to provide more context and examples of how the lecture content relates to the studio project, to help students better understand how to apply the concepts in a practical setting.

Aligning Lecture Content with Studio Project: The present study identified the need for improvement in the alignment of the timing of the lecture and related assignments with the overall timeline of the studio project. The content pertaining to anthropometrics, ergonomics, and usability studies was taught ahead of the studio project progress, with small assignments provided to students for practice. While these assignments were somewhat related to the studio project, they were not directly applicable, causing confusion among some students. It may be helpful to provide more context on how the assignments relate to the studio project, as one student felt that especially the prototype assignment results from the lecture course seemed more independent. Several students addressed that the alignment of the two courses could be improved. It may be practical to focus on one or two topics

related to the studio project, instead of five topics, and to align the timing and assignments accordingly. This will be easier for both studio and lecture instructors to coordinate the timing of the learning, especially when it is their first-time teaching collaboration.

Improving Idea Exploration Phase Preparation and Guidance for Students: Although the majority of students reported feeling adequately prepared and receiving appropriate guidance throughout the five phases, the survey responses indicated that certain students perceived a lack of preparedness and insufficient guidance specifically during the idea exploration phase. A noteworthy difficulty identified among students pertains to the different priorities of the two instructors and guest reviewers when seeking individual feedback for assignments. For instance, the Human Factors lecture course instructor placed greater emphasis on the shape and dimensions of the generated ideas to enhance tool usability, not necessarily intending to provide detailed guidance on the overall design quality, including considerations of aesthetics, branding, and more. To avoid this confusion, it will be beneficial for the instructor to enhance the design of assignment statements by incorporating clear evaluation criteria and scope, with both written and visualized examples, enabling students to better understand the type of feedback they can expect from each instructor and guest reviewers.

Improving Usability Study Guidance and Support for Students: Also, based on students' feedback, additional supporting materials for conducting the usability test could have been better provided. To improve the quality of guidance, it may be beneficial to provide more usability study examples for students to refer to when planning and conducting tests, as well as clarify roles and responsibilities during the usability study.

Improvements for the Future Study: It is important to note that self-report surveys may present challenges in terms of interpretation, particularly when dealing with limited respondent numbers. Future research endeavors should explore additional assessment methods, such as employing expert-panel evaluations to gauge the quality of student work products in comparison to a baseline year devoid of collaborative experiences. Also, it is recommended to improve the design of the Likert scale used in surveys, especially the response options such as "so-so" and "could be better" may not provide clear distinctions for certain survey participants.

5. CONCLUSION

By taking Human Factors into account during the industrial design process, it becomes possible to develop solutions that are both usable and valuable, thereby enhancing productivity (Kim & Joines, 2020). This research study has provided valuable insights into the potential benefits arising from the collaboration between the studio and human factors. The content students received in the Human Factors course strongly influenced every step of the design process in the studio course, which benefited students learning by offering a more well-rounded approach to design research, ideation, testing, and

final design execution. It also bridges the gap between theory and practice by providing students with an opportunity to apply the theory they learned in the human factors class to the studio project.

The findings of this study have important implications for design educators and institutions seeking to enhance design education and improve student learning outcomes. The identified challenges include the alignment of lecture content with the studio project, establishing constant communication between the two courses, and providing guidance and support for conducting usability tests. To address these challenges, the recommendation includes establishing a communication protocol, a shared platform for collaboration, a more flexible lecture curriculum, and providing more examples and guidance for conducting usability tests. By incorporating these findings into their design curricula, educators can help students to develop the skills and knowledge needed to succeed in the field of design, ultimately leading to better quality outcomes for their portfolios.

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