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Teaching Ergonomics in the Online Studio

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Abstract: Human factors and ergonomics are very important considerations for the built environment. Usually, such issues are taught in the design studio courses in architecture education. Traditional design studio in architecture program follows the ideology of learning by doing. Design studio is more than a physical space, it is a culture with particular focus on one-to-one interaction and lateral learning. This learning program had to be suddenly switched to distant learning mode during the COVID-19 outbreak. Teaching human factors in design studio usually takes thorough exercise for both the instructors and learners, unsurprisingly in the online studio this exercise gets even more challenging. This article portrays the experience of such a challenging task and responses to the emergency situation of online learning. This article is based on participant observation and qualitative analysis of the observation protocols. The experiences can be useful for both designing human factors and distance learning in studio-based programs.

Keywords: Human factor, Ergonomics, Design studio, Online studio, Architecture education

Introduction

The Human Factors and Ergonomics Society considers ergonomics as the application of knowledge about people, their abilities, characteristics, and limitations to the design of equipment they use, environments in which they function, and jobs they perform (Human Factors and Ergonomics Society, n.d.). The International Ergonomics Association considers ergonomics as the scientific discipline concerned with the understanding of the interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimize human wellbeing and overall system performance (Internation Ergonomics Association, 2000). Naturally, ergonomics is an important consideration of the built environment (Attaianese, 2012, 2017; Attaianese & Duca, 2012; Biswas et al., 2021; Charytonowicz, n.d.; Costa et al., 2012; Eilouti, 2021; Garneau & Parkinson, 2016; Hendrick, 2008; Olguntürk & Demirkan, 2009). It is also vital for sustainable development because it contributes to the social and economic dimensions of sustainability (Radjiyev et al., 2015). However, ergonomic approach in the built environment is not well recognizes in the academia (Attaianese & Duca, 2012; Costa et al., 2012; Fross, 2014) with few exceptions in health care architecture (for example Codinhoto et al., 2009; Pinto et al., 2000; Rogers et al., 2013; Villeneuve, 2000; Yeoman & Ashmore, 2018). Accepting the scarcity of ergonomic approach, the necessity of integrating ergonomics into architecture is recognized by scholars (Attaianese, 2012, 2017; Attaianese & Duca, 2012; Garneau & Parkinson, 2016; Olguntürk & Demirkan, 2009).

Specifically, in the academic enclave, it is often considered that teaching ergonomics in design schools have proven success in improving performance, productivity, safety, and health in

the built environment (Attaianese, 2017; Attaianese & Duca, 2012; Garneau & Parkinson, 2016). In the formal education of architecture, ergonomics is usually taught either as separate lecture course and/or within the studio course. Design studio approach of teaching ergonomics is highly appreciated for its fruitful results in improving the ergonomic application in other disciplines also along with the architecture school (Biswas et al., 2021; Moody, 2011).

This article reports a design studio approach of teaching ergonomics in architecture during the COVID-19 pandemic. The pandemic situation has exerted heavy impact on architecture education, especially the design studios. Design studio is the heart of architecture education, it is not only the physical space where classes are conducted or students exercise, rather, it is a culture with particular focus on one-to-one interaction, critique and lateral learning that is carefully nourished (Abdullah et al., 2011; Datta, 2007; Hacihasanoglu, 2019; Vyas et al., 2013). Alternative of studio was beyond imagination, at least until the pandemic situation - which had turned a lot of incredible situations in the studio teaching into reality. Online design studio was, probably, never seen as a mode of studio teaching which had to be the reality for almost two years. This article presents a case report of how the critical issue of teaching ergonomics was conducted in a more challenging situation of online studio course at the Department of Architecture, Military Institute of Science and Technology (MIST), Bangladesh.

Teaching Ergonomics in Design Studio

Architecture education revolves around the design studios, the core of the program. Usually design studios follow an ancient philosophy of learning by doing, which was first introduced by the Ecole Nationale et Speciale des Beaux-Arts in Paris (Alagbe et al., 2017; Chafee, 1983). This ideology was modernized and then familiarized by the Bauhaus School, established by Walter Gropius in 1919 (Alagbe et al., 2017; Bailey, 2005). With necessary adaptations, still most of the architecture schools around the world follow this ideology and delineate design studios for solving complex, open-ended problems (Belluigi, 2016; Kuhn, 2001; Ledewitz, 1985; Schön, 1987). Studios support the students to learn, adapt and apply design principles that would aid their competence in the professional field. Usually in the studio courses, ergonomics is taught through lectures and design exercise so that the students can apply the acquired knowledge in their design and thus carry forward the learning.

This article presents the studio exercise of teaching ergonomics at the Department of Architecture, MIST. The Department of Architecture, MIST, follows the conventional five-year-long academic program with ten successive design studio courses. The first two of them are introduction to design principles and the third one is the first studio that initiates architectural design process. Ergonomics is taught in this studio, which is ARCH 2101: Design Studio III. Ergonomics is a major component of this this studio. In addition, basic understanding of human activities in architectural space and analysis of function and program are the core components of this course. This article depicts the experiences of the ARCH 2101: Design Studio III in the Spring 2021 semester during the pandemic situation. It is based on participant observation of this studio course. The author was in lead of the studio and designed the studio course along with other two studio instructors. The course was designed with three projects, the first was a two staged study of anthropometry and human activities, second was a small kiosk intended to incorporate ergonomic considerations into design and the last was to design a single-family residence expected to incorporate all the course objectives delineated for this studio. This entire course was conducted online, and notes were taken each week to keep track of the studio progress. These notes were considered as observation protocols and analyzed qualitatively for this article.

The entire Spring 2021 semester was conducted during the lockdown situation. Therefore, online studio was the only way to conduct the course. Online mode of studio had been introduced in 2020 and by the time of the Spring

2021 semester, students and instructors had some orientation on the online studio. ZOOM and Google Classroom provided the online platform for the studios. All attempts were made to conduct the studio as close as possible like the regular studio course, it was not easy as it sounds.

From the three studio projects, this article illustrates only one which was solely dedicated to learning ergonomics and incorporating ergonomic considerations into architectural design. The project was designing a food kiosk considering ergonomic requirements for two particular persons to work in the kiosk. Before this project, a two staged study was conducted. The first stage was to understand the human body and anthropometric dimensions that are critical for space designing. Second stage was an elaborate study of human activities in space and spatial dimensions. These two exercises supported the basic understanding of the students for architectural design. This project was a group exercise, students formed groups of two members and each group had to design the kiosk considering the ergonomic requirements for that group members. The design had to be accommodated within space and it was required to design preparation, cooking, and serving of a particular type of food selected by the students. This setting of food selection and ergonomic requirements for two particular persons was purposefully designed, so that the students can internalize the concepts of anthropometric and ergonomic application, which is expected to nourish their understanding and design thinking process. Additionally, this offered a lot of variations in the design outcomes. This kiosk project was devoted to ergonomics only and it did not deal design issues like site, climate, environmental impact, structure etc. in detail. It only considered orientation for primary considerations of natural lighting, ventilation, rain, and glare.

The course was intended to familiarize ergonomics principles to the students as well as introduce understanding of built forms, functional arrangement, and context. The relevant course objectives (CO) include concept of ergonomics, understanding of human activities in architectural space, and analysis of function and program. Learning objectives (LO) relevant to ergonomics include

- Ability to understand and analyses human activities based on ergonomics
- Ability to determine space requirements based on ergonomics
- Ability to design object or space for specific function and ergonomics

Learning objectives (LO) and intended learning outcomes (ILO) for the kiosk project were set considering the fact that due to the pandemic situation and lockdown induced restrictions students would not be able to get hands on training and conduct field survey. The LOs were

- To learn the anthropometric and ergonomic dimensions to design a food kiosk in the local context.
- To develop an understanding of efficiency and optimization of working space.
- To apply the knowledge of ergonomics in designing the kiosk.

The ILOs expected that the students would be able to

- Determine the ergonomic requirements for an efficient and comfortable working space.
- Design space considering ergonomic requirements.
- Focus on the difference in standard and local requirements.
- Design customized furniture/space and relate with the optimum standard.

Learning of ergonomics starts with understanding the human body. In the project, the first task was to develop an understanding of what body dimensions are to be considered for the activities performed in the kiosk. Relevant postures and activities were selected based on architectural space standards mentioned in different reference books. The books consulted for this project are as follows.

1. Time-Saver Standards for Building Types (De Chiara & Callender, 1990)
2. Human Dimension and Interior Space (Panero & Zelnik, 1979)

3. Neufert Architects Data (Neufert & Neufert, 2012)

The next step was to develop a clear understanding of the human activities to be performed in the kiosk. Here, each of the groups selected a specific food to be served in the kiosk and studied the entire range of activities and function such as storage, preparation, serving, operation and maintenance as well as the required equipment/gadget for that particular food. The groups studied respective human activity and sequence, body dimension for the relevant posture, dimensions of the relevant furniture/fixture/appliance, the relationship between the human body and furniture/fixture/appliance, required clearance between the human body and furniture/fixture/appliance and/or wall surface, clearance required for the movement of the human body to perform the activity, etc. Students presented their study of ergonomic considerations and kiosk function through oral presentation and report. Glimpses of the study of anthropometric and ergonomic features and the kiosk function are shown in the following figures.

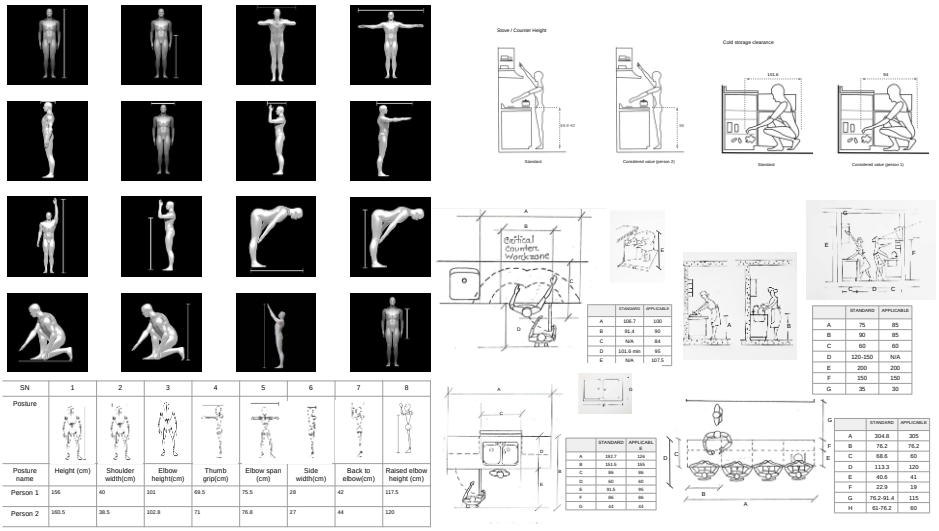

Figure 1: *Study of ergonomics*

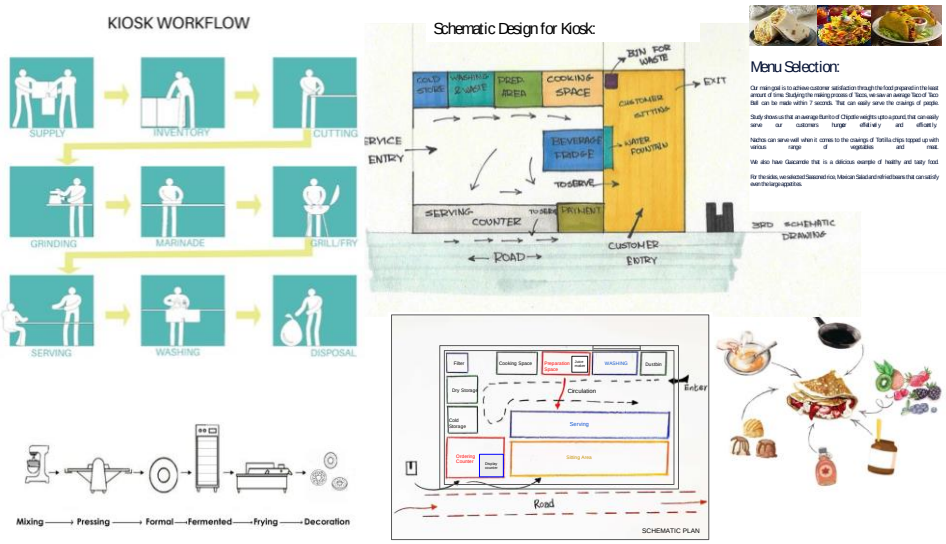

Figure 2*: Study of kiosk function*

After the study, students designed the kiosk. The kiosk had to fulfil the following requirements.

- The design must be customized for the two group members in terms of ergonomic application.
- All necessary functions of food preparation, cooking, serving and storage must be accommodated.
- All the furniture/fixture must comply with the ergonomic considerations of the group members and accommodate the necessary equipment (for cooking, preparation, storage etc.) comfortably.
- Space must not be wasted, but the comfort of working/movement cannot be sacrificed.
- Basic climatic considerations should be accommodated such as natural lighting and ventilation, protection from glare and rain, etc.
- Customized and innovative design of furniture to save space and increase efficiency is highly appreciated.

Students developed their design gradually and presented several times before finalization. There were two critique sessions, the first one was informal and to support the students in design development while the final crit was formal and included external members from other studios of MIST and members from other schools who joined virtually. In the informal crit, each group presented their design followed by discussion. The discussion was open for other students to facilitate lateral learning. Finally, students submitted their designs in the form of presentation containing images of the models and drawings and live video of the models. It was recommended to make the roof operable in the model to increase the visibility of furniture/fixture arrangement. Some of the models and drawings are presented in the following figures. Model and drawings were prepared at 1:25 scale.

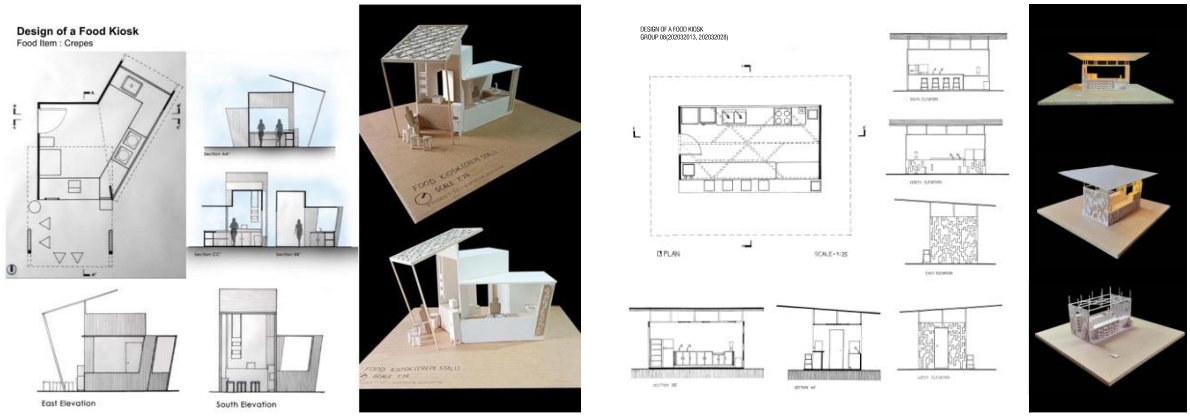

Figure 3: *(left) Crepes Kiosk by Kaniz Tahsin Masud and Mubassira Bin Jannah, (right) Kiosk for Raita & Pakora by Tasin Tasfia and Mehedi Hasan*

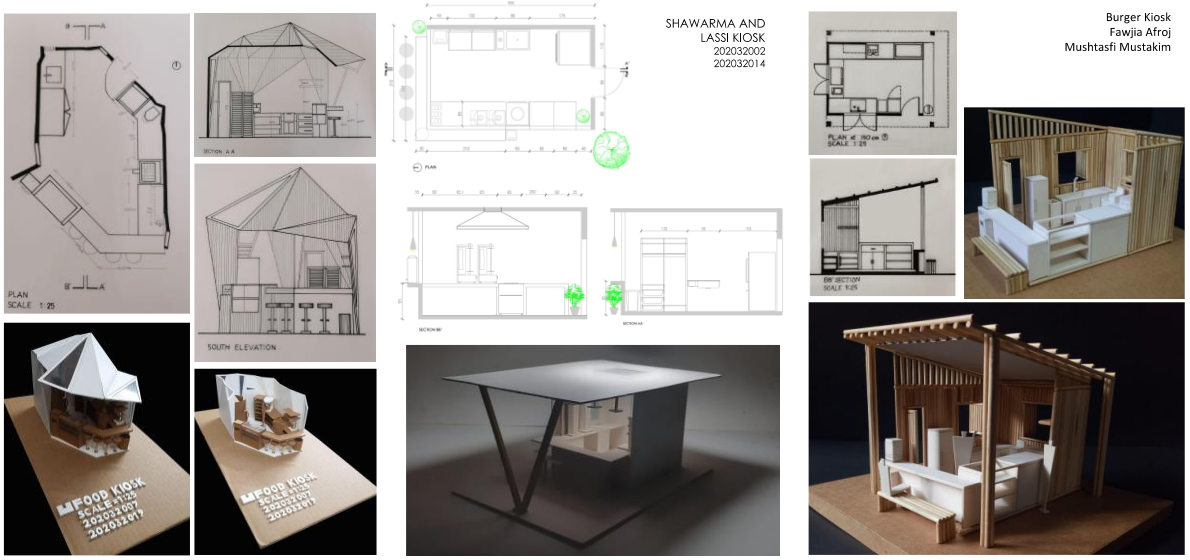

Figure 4: *(left) Doughnut Kiosk by Khawla Binte Khalid and Rifah Rezwana (middle) Kiosk for Shawarma & Lassi by Mohammad Munzurul Haque and Md. Munzurul Haque, (right) Burger Kiosk by Fawjia Afroj and Mushtasfi Mustakim*

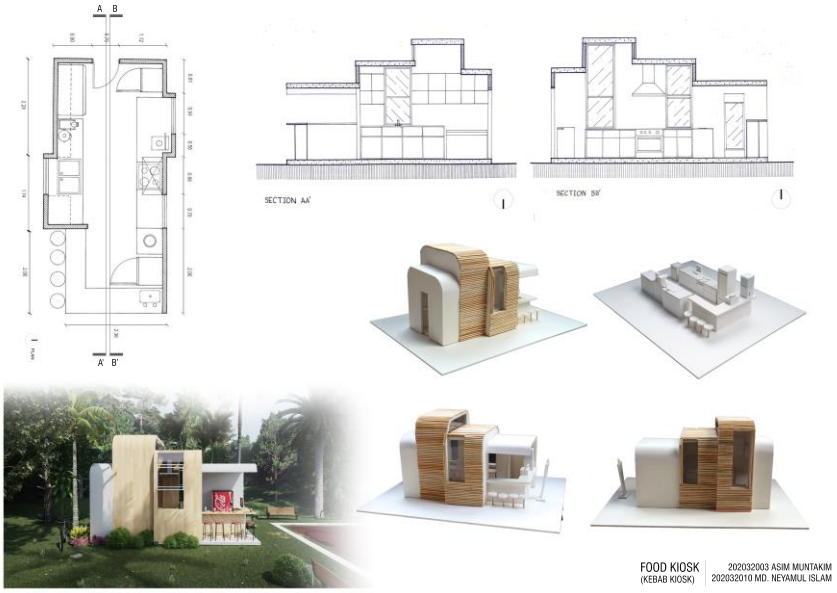

Figure 5: *Kebab Kiosk by Asim Muntakim and Neyamul Islam*

Discussion

The studio was conducted online, which was a major challenge even though the online studio was introduced in the previous semester and the students had some orientation. This course was the introductory studio for architectural design learning, and this food kiosk was the first space design project in the academic program. Naturally, they needed enough discussion and guidance for design development. In such initial stage, students usually need support to start a design project and then to proceed for development and achieve the requirements. This was quite a challenge for both the beginners and the studio instructors.

Studies mention that learning by doing ideology of design studio is sometimes difficult for the

students in the early stage (Al Maani et al., 2021). Quiet naturally, it was more demanding in the online platform. Teaching ergonomics usually requires rigorous exercise, discussion and demonstration in the studio (Biswas et al., 2021). These issues were difficult in the online platform. Demonstration of anthropometric and ergonomic consideration was critical. Usually, the instructors demonstrated different body postures in the ZOOM meetings through live video and then they asked the students to mimic them. Yet, students struggled, particularly to deal with scale in the initial design stage. It was difficult for most of them to perceive the dimension of a space required for a specific activity, for example, working with a kitchen sink. In such case, the instructors tried to show how it works with a dummy sink, made with whatever was available at hand (for example, a chair was converted into a sink with adjusting the height and putting some cardboard on the arm rest to get the required height). Then the students, whoever could avail, also tried to make similar dummy space, mimic the activity, measure the dummy, and make necessary changes in the dimension if required. This type of video demonstration was very helpful to develop understanding of scale and ergonomics, though demanding.

Usually, students presented their designs in the ZOOM meetings through PowerPoint presentations, sometimes they showed snapshots of designs. This mode of presentation made design discussion difficult, for both the instructors and students. Presenting a study was easier to handle with PowerPoint, but presenting a design was not. Scale, again, was a critical issue for preparing drawings and models. In a regular studio, usually such projects were exercised at 1:10 scale with hand drafting and mass model. This scale was not workable for presenting with PowerPoint or live video, and there was scarcity of stationary supplies like butter paper, styrofoam etc. Therefore, students were suggested to work on 1:25 scale that fits on a A4 paper and easy to transform into snapshot or PowerPoint presentation. They were suggested to work with drawings and mass models including all necessary furniture/fixture of the same scale and always put a human figure in the mass model to perceive the space. This was convenient and useful.

From the instructors' side, additional hurdle was to provide feedback and design guidance on drawings and models. Students made study models and discussed with showing images from different sides and live video in the ZOOM meetings. For drawings, students shared the images of their manual drawings, and the instructors draw remarks on their drawings with the help of annotation or whiteboard option in the ZOOM. Students kept snapshots of the remarks and exercised accordingly. However, providing suggestions on the mass models was difficult, it had to be through video. The instructors made some comments to improve the model seeing it in the video and then the student made the adjustments immediately and showed the model again. The instructors struggled to provide design feedback to all the students in the assigned studio time, often the classes were longer and additional sessions had to be offered. The course was designed for 12 hours per week. However, the course required 15-16 hours per week and sometimes additional 1-2 hours were taken in the weekend. These extra hours were beneficial for the learners, especially those who took a slower pace to cope up.

Unlike the regular studio, students did not have the opportunity to work together, they had to work separately. So, they communicated through digital platform, they used the ZOOM dedicated for the studio. Besides, each group planned for communication, such as ZOOM meeting of their own, cell-phone conversation, WhatsApp, Viber, social media etc. They decided the postures, then took measurements and studied the convenient dimensions that suit them. They studied the kiosk function through literature and video study. For example, one group decided the product as kebab and fixed the selling quantity per day, then they studied kebab preparation procedure, serving, storage requirements, operation, maintenance procedure etc. They also studied the equipment and furniture that are required to prepare kebab. Usually in such case, students always studied

the function from real life examples, however due to the lockdown situation, the students had to rely on literature and videos available online. YouTube was the most popular source. Different food vlogging or recipe sites were also useful. Although hands on experience had to be compromised, but there was a bit of compensation with the variety of information. Following the function study, each group checked if there was any difference between the reference standards and their own measurements. Students designed the kiosk customized for themselves following their own measurement.

From the students' side, additional challenge was to prepare models and drawings due to the unavailability of stationary supplies. Usually in the second-year level, students have to prepare drawings and models manually, digital communication is not encouraged. Following the pragmatic situation, students were allowed to prepare drawing with pencils in case drafting tools were unavailable and make models with whatever was available to them. Therefore, students made mass models with materials at hand. Luckily, by 2021 a few stationary suppliers started home delivery and some students utilized this.

Online studio had been introduced in 2020 and this course was conducted in 2021. The students were in the second year, and they had completed more than half of their first-year education online. This was a difficult situation on one hand, while there was a bit of experience for both the students and the instructors on the other hand. Previous experience made it clear that a well-organized structure for the studio projects and making it clear to the students was helpful to achieve the learning outcomes. Along with the technical difficulties for studio exercise and communication, it was felt from the educators' perspective that the online studio had some social and emotional issues that were quite newfangled. The students were in the early stage, and they needed support through direct interaction and peer sustenance. The studio culture was malnourished in this regard, and the students suffered. Sometimes, there was helplessness and uncertainty, for everyone. There were Covid-19 patients among the students and/or their family members which simply aggravated this emotional state. Lack of privacy of varying range was another issue. Nevertheless, there was constructive achievements as well, this situation enforced all to learn new digital tools, acquire new skills, explore different ways and stay structured. By the end of the project, the students' performance demonstrated that the LOs and ILOs were achieved considerably and there was not much to worry too much. Although, the goals were a bit compromised in the first place.

Since the outbreak of Covid 19, the entire education system experienced a radical shift. In the architecture education, it was critical, because the education program is heavily dependent on one-to-one interaction and lateral learning by its nature. The program had to adapt to the 'new normal' situation quickly. Challenges, prospects and way forwards of online studios are in the academic discussion in the recent time. Such studies have identified several challenges for studio courses from for the learners and educators. A major challenge for the learners in the early years of the program is the difficulty to cope with learning by doing mode of studios (Al Maani et al., 2021). Others include, technical difficulties and coping with the technology (Al Maani et al., 2021; Alnusairat et al., 2020; Ibrahim et al., 2021; Varma & Jafri, 2020), lack of direct interaction and feedback (Al Maani et al., 2021; Alnusairat et al., 2020), stress (Alnusairat et al., 2020), lack of privacy (Ibrahim et al., 2021) etc. Nevertheless, there are achievements like learning digital tools, online workshops, virtual presence of experts etc. (Ceylan et al., 2020; Milovanović et al., 2020). This studio experience is aligned with these studies.

In a nutshell, this studio demonstrated that despite the difficulties, it is possible to manage distance learning for studio-based programs with some considerations along with technical issues. They are summarized as follows.

- Probably, the most important consideration is the perspective, online studio cannot replicate conventional studio verbatim,

therefore studio projects should be designed pragmatically.

- A clear structure of the studio project with due consideration of modality, criteria, outcomes etc. helps the students to stick to the project. It is equally important to explain the structure and the criteria to the students so that they know what, why and how to work on the studio project.
- For conducting the studio, at least 25% additional time should be considered.
- A separate arrangement for student interaction can benefit them.
- Specifically for teaching ergonomics, special demonstration arrangement for the instructors is required to make the students understand the foundation of space design.

Conclusion

Learning human factors and ergonomics is an essential component of architecture education. However, there is a research gap in the field of design studio pedagogy for teaching ergonomics. This article reports a design studio case of teaching-learning ergonomics during the Covid-19 pandemic. This demonstrates a structured approach of studio exercise that led the students to develop an understanding of ergonomic considerations and exercise of ergonomic application in a design project step by step. The online studio experience also portrays the endeavor to cope with the 'new normal' situation. With a clear structure of the project exercise, detail feedback to the students and additional efforts, online studios can manage the basic activities of a design studio. Online studio can be beneficial for enhancing digital competence and innovative thinking. However, the social and emotional dimensions of the studio culture are difficult to handle online. This studio case might be helpful for the pedagogical pursuit of integrating human factors in architecture education as well as considerations for distant studio learning.

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