Designing learning spaces via an international and interdisciplinary collaborative design studio - an example of collaboration of engineer architects with pedagogy students

Dorota Wojtowicz-Jankowska†, Einat Gil‡ & Ziemowit Belter†

Gdańsk University of Technology, Gdańsk, Poland†
Kibbutzim College of Education, Technology and the Arts, Tel Aviv, Israel‡

ABSTRACT: The study explores the dynamics and outcomes of an international interdisciplinary design studio focusing on innovative learning spaces. Conducted over two years between students of the Faculty of Architecture at Gdańsk University of Technology (Gdańsk Tech), Poland, and pedagogy students from the Kibbutzim College of Education, Technology and the Arts in Tel Aviv, Israel, this design-based study examines the contributions of a unique educational setting to student learning, the design process evolution and collaboration, and the challenges and opportunities that arose from the complex context. Students tackled real-world design challenges and employed digital collaboration tools. The analysis utilised two structured questionnaires to evaluate key aspects of the design process, with a significant self-reported value of acquired knowledge and skills for both courses and an increase in maximum satisfaction ratings in the second year, suggesting a more engaging and rewarding experience for dedicated students.

INTRODUCTION

The presented research is the result of a two-year collaboration between two academic institutions: the Faculty of Architecture at Gdańsk University of Technology (Gdańsk Tech) in Poland, and the Kibbutzim College of Education, Technology and the Arts in Tel Aviv, Izrael. The collaboration was initiated between the Centre of Innovation and Learning Design and the Department of Environmental Design in the Faculty of Architecture in the academic year 2021/22, and was continued in the following year 2022/23. The proposal for joint work came from the Israeli side, which already had experience in collaborating with another similarly profiled Polish academic institution. However, collaboration between diverse faculties, such as pedagogical and engineering disciplines, posed a challenge. Changes in perceptions of teaching and learning significantly affect educational spaces, with an increasing aim to design in a flexible way [1]. Therefore, the reason for starting the collaboration was to investigate how interdisciplinary approach will contribute to the participants of both disciplines.

COLLABORATIVE DESIGN STUDIO

A collaborative design studio represents a new model of architectural education, merging the diverse expertise and perspectives of individuals to address complex design challenges collectively [2]. This model transcends the traditional design studio framework by fostering an environment, where interdisciplinary collaboration is not just an encouraged addition but an integral core of the learning process [3]. In such studios, students from architecture, engineering, environmental, social science, and other fields come together to work on projects that demand a broad range of skills and knowledge. A collaborative design studio could also be created among architects that work together, sharing openly their knowledge, skills and research. The essence of a collaborative design studio lies in its dynamic nature, encouraging students to engage deeply with real-world problems, necessitating innovative solutions that are socially relevant, environmentally sustainable and culturally sensitive. This approach not only prepares students for the complexities of contemporary architectural practice but also instils in them a deep appreciation for the value of teamwork and cross-disciplinary dialogue [4].

Key elements of collaboration between architects and pedagogical faculties included establishing a set of objectives. Together, as an international team, and individually, as separate groups working on specific programme content, the following goals were adopted:

• Learning about theoretical and practical aspects of the design of active/future learning spaces.
• Investigating how the design of learning spaces can meet pedagogical and educational needs.
• Promoting skills in design thinking and problem-solving through design.
• Fostering interdisciplinary and international collaboration within socio-cultural academic contexts.

LEARNING SPACES

Active, flexible or future learning spaces are theoretical concepts that have been introduced over the past 30 years and are part of the unfolding reality in higher education and schools on a few continents. They are related to the changing educational environments of the 21st century that incorporate innovative pedagogies, attention to socio-emotional aspects, promoting learner-centred experience and including diverse technologies. It represents a change to the traditional teacher-centred approach that supports passive learning in a classroom setting, arranged in a fixed format.

Three main characteristics describe future/active/flexible learning spaces: dynamism in the arrangement of the space; teaching in different pedagogies to enable a variety of learning experiences; and use of interactive and up-to-date technologies for visualisation, collaboration and communication. These spaces often encourage independent learning and teaching lessons, with participants experiencing collaborative, interactive learning, working in groups, and using technologies, where the learner can share responsibility for the content, technology and space [5]. Recent Horizon reports include learning spaces as part of the current trends in education [6].

Education and architecture, empowered by new collaborative opportunities, can create updated architectural solutions that support new pedagogies, allowing for greater movement and interaction and offering a variety of spatial experiences. The behavioural expectations are reflected by the architectural language of *design cues* of the space, and therefore influence behaviours [7].

UNIQUENESS OF THE STUDY AND STUDY AIMS

Considering that the collaborative synergy of architects and teachers can change the design of the learning environment and schools, a course was designed to bring these two professions together. The collaboration's main objectives were to:

- develop an environment of collaborative design studio for tackling complex design problems that are emerging from authentic pedagogical needs;
- develop an interdisciplinary approach to architectural and urban design issues;
- encourage multicultural and international inclusive relations and promote interdisciplinary learning approaches.

In the context of an academic course, which aims to build knowledge about learning spaces and promote students' competencies regarding the design of learning environments and spaces, in an international interdisciplinary learning environment, the research questions were:

1. How participating in the course contributed to students' learning?
2. In what way did the design process and collaboration improve?
3. What challenges and opportunities emerged in the international interdisciplinary design studio created through this collaboration?

METHODS

This study employed a design-based research approach [8] that aims to develop and implement new learning and teaching methods, and produce data-based insights about learning and teaching that build on, and contribute to, theoretical knowledge in the field. Key characteristics of design-based research are expressed in the study by Cobb at al [9]. Particularly important is offering an intervention programme that aims to contribute to theory; being reflective about the learning and design process; including more than one iteration; and operating in the field - the natural setting where the intervention takes place. The term iteration, which means repeating a planned activity more than once, is common in design-based research, to test and refine the design, which was done in the international instructional team.

The field of research was an international, interdisciplinary course that took place in a hybrid format, at Gdańsk Tech and the Kibbutzim College as part of the academic studies and teaching. Two iterations took place over the two years the course was conducted. The participants were MArch students and MEd students in the technology in education programme. The education students were by majority in-service teachers for kindergarten to high school, from different disciplines (e.g. languages, mathematics, science). Students worked in six-seven international working groups of four-six students in each group, two architecture and three to four education students (Table 1).

Table 1: Number of students participating in the design studio.

Iteration	Education students (IL)	Architecture students (PL)	Yearly total
Iteration 1 - 2022	25	15	40
Iteration 2 - 2023	25	15	40
Group total	50	30	80

The data were collected using various research tools. The first structured questionnaire focused on the learning gained by the participants, effectiveness of the teaching methods and future use of the gained knowledge. It contained open and

closed questions. The questionnaires underwent content validation [10] by the researchers with two additional persons involved. Since conducting the course was complex combining language and cultural issues, hybrid format and ethics restrictions on the instructors, there were some data collection challenges, especially in the first questionnaire. This resulted in a relatively low-medium percentage of completion of the first questionnaire - 33% (iteration 1) and 63% (iteration 2).

The second questionnaire pertained to the interdisciplinary design process. A structured questionnaire was designed to evaluate the interdisciplinary and international collaborative design process between architecture and education students. This questionnaire was meticulously constructed to assess key dimensions of the collaboration: efficiency, effectiveness, management, innovation and the use of tools. Each category had three follow-up questions. The rationale behind this multifaceted approach was to capture a holistic view of the collaborative experience, drawing on the framework of Sawyer and DeZutter [11], which emphasises the importance of assessing collaborative learning through multiple lenses to understand the complexities and dynamics of interdisciplinary work effectively. Each category within the questionnaire was aligned with specific research objectives, aiming to dissect the nuanced aspects of collaborative design, from initial problem-solving to the final product's potential for future implementation.

The questionnaire was administered at the conclusion of two consecutive academic years to capture temporal variations and ensure the reliability of the findings over time. This longitudinal approach, inspired by similar studies in the field of design education, such as Wojtowicz [12], allowed the researchers to observe trends, shifts in perceptions and the evolution of collaborative skills among participants. To ensure the validity of the questionnaire content, items were developed based on established literature in collaborative learning and design pedagogy, and further refined through expert review, adhering to the methodological guidelines for educational research. The inclusion of a broad spectrum of response options, ranging from 1 - *not agree at all* to 5 - *very much agree* was intended to capture the diversity of student experiences and perceptions, providing nuanced insights into the efficacy and challenges of the collaborative process [13]. The second questionnaire was given only to architecture students, as it was measuring their perspective on the design process. The completion rate was 93% (14 out of 15) in 2022 and 80% (12 out of 15) in 2023.

Additionally, design documents were prepared supplementing a researcher's log after each class, in which design considerations and researcher impressions were documented. Learning outcomes (e.g. design process and results) were examined with another tool to assess innovation, collaboration and the depth of considerations. The study received the approval of the Ethics Committee at the Kibbutzim College. The students expressed their consent to participate in the study in accordance with the rules for ensuring the ethics of qualitative research. All efforts were made to ensure there would not be any impact on course evaluation by the instructors.

Analysis of the Questions - Descriptive Statistics of Students' Responses to the Questions

For the open questions, content analysis was used to identify central themes in the data [14]. The analysis of the design documents and the researcher's log helped to update the learning trajectory and to adapt the design. The use of various research tools facilitated the response to the respective research questions.

RESULTS: CONTRIBUTION TO STUDENTS' LEARNING

Most students were familiar or somewhat familiar with learning spaces before the course (92% IL, 100% PL). Only some of them had prior experience in designing learning spaces with more experience in the later iteration and for the architecture students (30% 2022/64% 2023) (Figure 1).
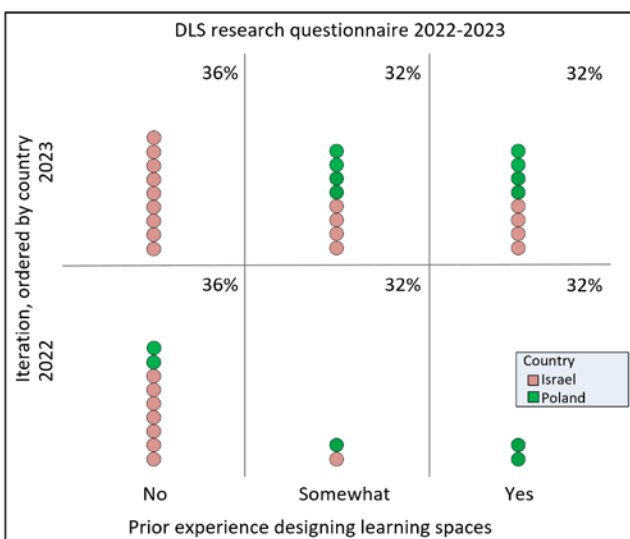

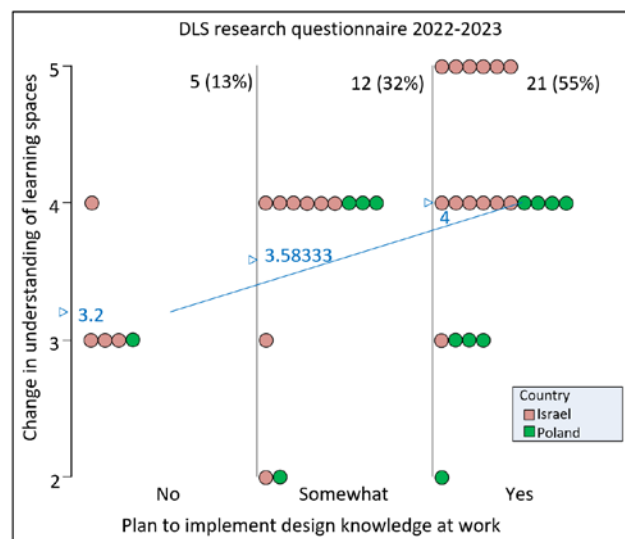Figure 1: Prior experienced designing learning spaces (DLS).

Figure 2: Students plan to implement design knowledge at work in relation to change in understanding learning spaces.

The course provided theoretical and practical knowledge for designing learning environments and spaces. Thus, in response to the question: *To what degree your understanding of* learning spaces *has changed during the course?* - the students reported that they experienced a change in their understanding of learning spaces. This change was greater for the education students (M_{IL} = 3.96, M_{PL} = 3.38) with no significant difference between the two iterations.

In articulating their understanding of learning spaces, the students explained:

- *A space that encourages exploration, gaining new knowledge and experiences.*
- *A universal, open space that allows you to conduct cognitive processes in comfortable conditions and work in groups of various sizes.*
- *Learning spaces are spaces that combine physical space with in-depth thinking about supportive pedagogy.*
- *My current understanding is that learning spaces should take into account the physical characteristics of the space, however limited they may be, and that the importance of their planning is critical to promoting diverse, flexible and effective learning. A learning space that will look good but will not allow flexibility in teaching-learning methods, will not help or promote anything, except visibility.*

Apparently, both future architects and teachers relate in these examples to cognitive and physical aspects, with some relating to pedagogical aspects.

The students benefited from the course not only by gaining a better understanding of concepts, but also by creating specific outcomes - designing learning spaces according to educational needs. Group projects examples are provided in Table 2.

Table 2: Learning spaces groups' projects for 2023.

Group	Project name
1	English disco class
2	HEL pace: hybrid equal learning
3	Balanced classroom - a clean design to allow greater concentration and avoid distractions
4	Theatre in kindergarten
5	Learning spaces for mathematics
6	Classverse: adapted learning in an effective, experiential and immersive space with multi-sensory digital learning
7	Science classroom design including outdoor and in-class space, technology and promoting creativity

Each project of learning space consisted of a written and drawing part. The written part presented the challenges faced by the project group, and how they were solved by the design and the kind of learning activity that was implemented. Students also had to explain how the implemented solutions were unique. All propositions were shown on plans, in an axonometric view and visualisation, and later on presented in front of an audience.

Relating to practical implications for their professional life, when asked whether they were planning to implement some of the knowledge and/or design from the group project or course in their work - 93% of the Polish and 84% of the Israeli students considered applying the acquired design knowledge at work (*yes* and *somewhat*) (Figure 2). In the second iteration, more of the students answered *yes* to this question - 60% in 2023, compared to 46% in 2022.

Students explained how they planned to implement the acquired design knowledge by stating:

- *If I have an opportunity to design a learning space in the future, I will take into account the ideas and recommendations developed during the classes.*
- *I have a classroom space to design next year, I will apply some of the things in the classroom design.*
- *I would like to take part in a think tank on designing learning spaces.*
- *I will try to treat my education classroom as a somewhat flexible space and think about how I can change the existing structure.*
- *Knowledge regarding working with people with completely different background than architecture in process of designing* [is useful]. *Besides that, I am planning to focus on co-operation between architects and teachers in the future, because I think it is a great direction for the growing need of better education for architects and for learning spaces.*

It is interesting to see a possible relation between students' perceived change in their understanding of learning spaces and their plan to implement knowledge from the course at work. The higher the change, the more they are susceptible to apply it at their professional zone (Figure 2).

Upon reviewing the second questionnaire's results from two academic years, 2022 and 2023, the analysis reveals nuanced shifts and constants in the perception and experience of the architecture students participating in the international collaborative design studio (Table 3).

Table 3: Participation experience of architecture students across the two iterations - comparison.

Efficiency	Problem solving		Personal motivation		Process adaptability	
	M1 = 4.0	M2 = 3.9	M1 = 3.8	M2 = 4.0	M1 = 3.9	M2 = 3.9
Effectiveness	Deliver to the brief		Work ownership		Design rationale	
	M1 = 3.9	M2 = 4.5	M1 = 2.9	M2 = 3.7	M1 = 3.7	M2 = 4.0
Collaboration	Clear team objectives		Information sharing		Communication quality	
	M1 = 3.4	M2 = 3.7	M1 = 4.2	M2 = 4.9	M1 = 3.8	M2 = 4.3
Management	Define and understand		Innovative communication		Decision making	
	M1 = 3.6	M2 = 3.6	M1 = 4.3	M2 = 3.9	M1 = 3.9	M2 = 3.7
Innovation	High quality of design		Design's potential		Right concept	
	M1 = 4.1	M2 = 4.2	M1 = 4.3	M2 = 4.5	M1 = 4.0	M2 = 4.5
Tools	Miro		Zoom and Teams		Instagram	
	M1 = 4.2	M2 = 4.7	M1 = 3.5	M2 = 4.5	M1 = 2.4	M2 = 4.1

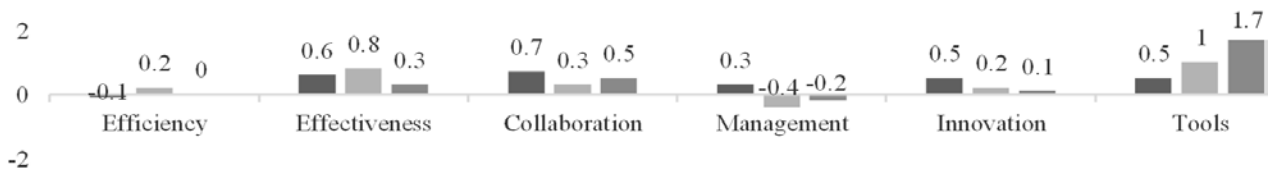Note: legend: M1 = mean for iteration 1 (2022), M2 = mean for iteration 2 (2023)

Figure 3: Change of the mean score in answers in scale 1-5 between the two iterations (2022/2023).

In examining the outcomes of successive iterations, the findings reveal improvements across several categories, with the most notable advances observed in collaboration, effectiveness and the use of tools (Figures 3 and Figure 4). While these areas demonstrate a positive trajectory, the results in other categories remained consistent, with the exception of management, which experienced a marginal decline. Interestingly, a comparison of mean scores with the percentage of students expressing the highest satisfaction unveils a consistently substantial rise in all categories.
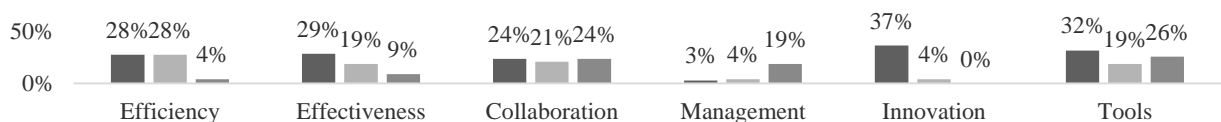

Figure 4: Change of the score in percentages for 5 out of 5 answers in design satisfaction between the two iterations (2022/2023).

This result suggests that while overall satisfaction has increased, the distribution of this enhancement is not uniform among the student population (PL students), indicating that the increase in satisfaction may be concentrated among certain segments of students.

CHALLENGES AND OPPORTUNITIES

The collaborative endeavour encountered several challenges, such as communication barriers stemming from linguistic disparities, unfamiliarity with disciplinary terms or technical tools. These impediments necessitated pedagogical approaches to facilitate effective exchange of ideas. Moreover, diverse fields of expertise among participants introduced complexity to the collaborative process, necessitating nuanced strategies to harmonise different perspectives and optimise collaborative outcomes. Cultural disparities initially seemed to be challenges, but were swiftly mitigated through the cultivation of mutual understanding and respect, fostering an environment conducive to productive collaboration transcending cultural boundaries. Also, navigating divergent academic calendars and temporal disparities posed logistical challenges, requiring meticulous coordination and adaptability to accommodate disparate schedules and time zones. Technological proficiency discrepancies and apprehension towards novel communication tools underscored the necessity for support and skill-building initiatives to enhance technological literacy and facilitate seamless interaction between students.

In summary, the collaborative endeavour was characterised by the adept navigation of multifaceted challenges, fostering resilience, adaptability and cohesive teamwork in pursuit of shared objectives. The collaborative endeavour presented numerous opportunities for growth and development across various domains.

Firstly, it provided a platform to enhance the practical aspects of work for architects, including refining communication with potential principals, meeting client expectations, incorporating customer feedback into designs and refining client interactions. Simultaneously, it offered educational opportunities for students to delve into and contribute to the creation of new active learning environments, thereby fostering a deeper understanding of educational dynamics and needs.

Secondly, the collaboration offered a chance to bolster social skills, encompassing improvements in language proficiency, acquisition of intercultural competencies, and enhancement of communication and information exchange abilities.

Thirdly, the project facilitated the development of technical competencies by providing support for navigating new computer programs, facilitating on-line and hybrid collaboration with team members, and enabling efficient information retrieval pertinent to design assumptions. In essence, the collaborative venture was not only marked by challenges but also abundant opportunities for professional, social and technical growth. By seizing these opportunities, participants were able to enhance their skills, broaden their perspectives and cultivate a more robust foundation for future endeavours.

DISCUSSION AND CONCLUDING REMARKS

In this international, interdisciplinary collaboration between Master of Architecture (MArch) and Master of Education (MEd) students, this study demonstrates how participation in the course contributed to students' conceptual learning and to their plans to implement the acquired knowledge. Throughout an iterative process spanning across two academic years, the second iteration of this collaborative design studio shows a notable increase in the highest satisfaction ratings for the design process. This suggests that the project became more engaging, challenging and rewarding for the most committed students. However, while average scores generally improved, they did not consistently reflect this positive trend, remaining static or even slightly declining in some categories. This variation may indicate that, although more students thrived in 2023, a few encountered additional challenges.

These findings emphasise the need for targeted support to ensure the studio meets the needs of all participants, not just the most engaged ones. The divergence in student experiences highlights the complex nature of interdisciplinary and collaborative education, necessitating nuanced approaches to teaching and learning. Despite numerous challenges related to language, culture, academic calendars and disciplinary knowledge, remarkable opportunities emerged from this international interdisciplinary design studio, such as contribution to students' social and professional skills. Currently, higher education and learning environments demand active and dynamic engagement, support collaborative learning processes, and also address the well-being of participants [15]. The interplay between space and learning has proven to be significant, as demonstrated in this two-year design studio. Acknowledging the role of space wherever learning takes place can serve as a supportive tool for educators, learners and architects.

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