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Integrative Design Classes for Environmental Sustainability of Interior Architectural Design

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Abstract: The paper considers the adjustments of the interior architectural design education model toward its compliance with the principles of sustainability, since the currently provided scheme does not effectively employ the sustainability multi-dimensional concept as a substantial determinant of interior architectural design. The conventional interior architectural design curriculum requires corrections, to provide students with systematized knowledge on sustainability issues, as well as appropriate abilities and skills to create buildings' interior spaces with high environmental performance. The modifications are considered using the example of a curriculum realized within the Faculty of Interior Design affiliated with the Academy of Fine Arts in Krakow. These improvements of the curriculum structure comprise the establishment of a compulsory course on environmentally sustainable interior architectural design, offering to the undergraduate students comprehensive theoretical knowledge on the multi-dimensional aspects of sustainability and the introduction of professional design tools, including simplified versions of multi-criterial environmental evaluation systems, as a supportive educational means, as well as learning tools comprising interdisciplinary environmental-responsibility-oriented design workshops or seminars led by green building consultants and professionals involved in practicing sustainable interior design. This paper discusses the innovative concept of integrative design classes (IDC), realized within the practical modules of courses on Building Construction and Environmentally Sustainable Architectural Design, both delivered to undergraduate interior design students. The paper analyses these integrative design classes as a supportive project-based learning technique to develop the students' ability to accomplish sustainable design strategies for resource efficiency, waste management effectiveness, optimization of indoor environment quality parameters as well as pro-environmental education. The results of the conducted integrative design classes proved that they are a driver for developing technically and formally innovative designs, allowing the students to establish a link between theoretical knowledge on sustainability in interior design and its practical implementation.

Keywords: interior architectural design; sustainable design; environmental contextualization; integrative workshops

1. Introduction

The necessity of implementing sustainability principles in the interior architectural design curriculum is not addressed explicitly in the official regulations accepted in 2007 by the Polish Ministry of Higher Education, which define the education standards at the Faculties of Interior Architecture. Still, there are other sustainability-related synonymous exigencies enclosed in this document that are commonly respected in the currently executed educational frameworks [1]. These general postulates, to be fulfilled within the teaching courses, comprise the following: (1) interdisciplinarity in the interior architectural design field; (2) holistic approach to interior design decision-making process; (3) exploration of the human–environment interconnection aspects of interior design

projects. The requirements, enclosed in the above-mentioned interior design education standards, although imprecisely formulated, seem to comply with the statement that interior architectural design teaching provides an excellent representation of sustainability education [2].

According to Guerin and Kang, sustainable interior design comprises "design in which all systems and materials are designed with an emphasis on integration into a whole for the purpose of minimizing negative impacts on the environment and occupants and maximizing positive impacts on environmental, economic and social systems over the life cycle of a building" [3]. Hayles identifies environmentally sustainable interior design (ESID) as a design concept focused on the materials' intended application, aesthetic qualities, environmental and health impacts, availability, ease of installment and maintenance, and initial and life cycle costs [4]. Jones, to define the area of interest of environmentally conscious interior designers, uses the term "environmentally responsible interior design" (ERID) to highlight its comprehensive perspective and indicate the interrelationship of the designed environment, human behavior, and environmental responsibility [5], where the last part refers to the health and well-being of the global ecosystems and the ecological consequences of mutual interactions between man-made and natural settings [6].

The successful accomplishment of these postulates requires, however, the revision of the traditional interior architectural design learning framework, toward an effective employment of the sustainability multi-dimensional concept, as a substantial determinant of interior design. These sustainability-oriented revisions of the currently exercised curriculum are indispensable considering that "much professional behavior is rooted in education and the precepts studied" [7]. Reforming the interior architectural design teaching framework to give it a pro-environmental perspective requires a comprehensive approach, considering that "learning goals associated with education for sustainability are more complex than those in many areas of study" [8]. These corrections are necessary to overcome the "sustainability gap" [9] still existing between theory and professional interior architectural design practice.

The structure of this article is as follows: the first part examines the coursework currently taught in an accredited interior architectural design curriculum. It is based on the analysis of the curriculum offered by the Faculty of Interior Design at the Academy of Fine Arts in Krakow. This section of the paper addresses the positioning of the offered courses within the existing interior design teaching programs, particularly in terms of the recognition of sustainability problems. The following section presents the areas of possible adjustments to expand sustainability issues within the interior design teaching framework. The corrections are focused on the development of innovative design methods and techniques to allow for the accomplishment of sustainability postulates, with emphasis on the employment of their environmental contextualization. The final section concerns the concept of integrative design classes as a supportive learning activity. The inquiry into this concept comprises its positioning within the interior design teaching program, as well as implications on the interior design students' perception of discipline environmental responsibility.

2. Sustainability Issues and Present Interior Design Curriculum

Interior design faculties in Poland are in 35% affiliated with academies of fine arts. These higher education institutions, due to their dedication to questions of space-creativity research, provide students with sustainability terms, mainly through the conventional knowledge-based learning models. The analysis of the existing interior design educational program is based on the program employed within the Faculty of Interior Design affiliated with the Academy of Fine Arts in Krakow, being referential to the proposed corrections within the existing curriculum. The study on the content of the above-mentioned teaching program proves its profound comprehension of the problem of interior design's complexity. It allows us to define the discipline's framework as "a program in the applied visual arts that prepares individuals to apply artistic principles and techniques to the professional planning, designing, equipping, and furnishing residential and commercial interior spaces" [10], as well as interior architecture understood as an instructional program providing knowledge on the "processes

and techniques of designing living, work and leisure indoor environments as integral components of a building system" [10].

The examined teaching scheme is built around the core courses on interior architectural design, executed within design studios, that occupies the central position in this centralized model. Design studios are accompanied by the core compulsory courses (i.e., descriptive geometry, architectural design, painting, sculpture, aesthetics, history of architecture, ergonomics, architectural design). Among the core courses are building-technique-related subjects, including structures and material technology, as well as a building construction course covering questions on building materials specification, material technologies, building code regulations, safety requirements, and accessibility for disabled persons. Some courses offered to first-year students as compulsory change their status to facultative in the following semesters. The supportive elective courses constitute the next group around design studios (i.e., history of furnishing, art history, technology transfer, theory of design). The teaching program also includes cycles of elective, monothematic theoretical lectures positioned on the periphery of this concentric scheme. One of them is a cycle of eight lectures, one of them weekly, on Environmentally Sustainable Architectural Design, based on multimedia presentations, discussions, and seminars on the selected case studies.

Students work traditionally within the interior design studios, which are organized as "horizontal studios" [11], that comprise only learners in the same year of study. This traditionally structured learning environment model, built around design studios, illustrates the definition of architecture and design education "as a form of problem-based learning, [which] has always been focused on the studio" [12], remaining a "critical venue for design students" [13]. The structure of this learning environment responds partially to the description by Hill as "an educational setting where students are physically located together in a common area utilizing manual or digital production methods" [14]. Students working individually on design projects within design studios are provided with comments and feedback every week from the same educator, presenting clearly defined design multi-dimensional demands (i.e., functional, formal, spatial, societal, aesthetic). The studies on collaborative learning and sustainable design recognize that the design studio environment makes for the ideal pedagogical structure [15]. Still, the interior design teaching framework that is currently employed, with the design studios traditionally positioned in a central place, although giving students the opportunities to address the sustainability questions within their design projects, concentrates only on the recognition of their selected aspects. Thus, this learning scheme conserves the fragmented and disconnected knowledge on environmental sustainability still found in interior design [1]. The implementation of the comprehensive methodology of sustainable interior design is neither sufficiently discussed within the core design courses or other taught subjects, nor employed carefully by the students. As a consequence of these conventional structures, educational framework "students do not see the relevance of sustainability in their specific area of study or find it hard to apply the learnings sustainability in their specific area of education" [16].

The interior design educational framework that is currently employed provides students neither with systematized knowledge on sustainability issues nor with appropriate competences to create interior spaces with high environmental performance [1,17]. Questions regarding the accomplishment of sustainability objectives in interior design are explained to the students by the educators depending on their personal training, knowledge, and commitment to practicing environment-oriented design. These problems range from the overall sustainability-related postulates (e.g., resource efficiency, effective waste management, energy saving, optimization of indoor environment quality) to very detailed questions concerning the application of environment-responsibility oriented design methods (e.g., shaping of constitutive interior components in order to perform as the "passive instruments for enhancement of building systems performance" [18], and design tools (e.g., resource or environmental drawings). Since the above-mentioned detailed subjects are discussed within the limited group of students attending the elective lectures on sustainable architectural design, the environmental responsibility problems remain unfamiliar to most students enrolled.

The discussed teaching program is based on a hierarchical scheme with the predominant place reserved for the design studios. As Gurel indicates, "a design studio can be an especially dynamic medium from which to have a strong position on and test the productive potential of sustainability" [19]. As she continues, this specific learning environment allows students to "apply knowledge attained from coursework to a specific project" [19]. This is hard to confirm in the case of the analyzed curriculum, since the cycle of theoretical lectures on sustainability offered to the students within the existing teaching framework has the same status as the elective lectures.

Since the theoretical courses alone are not sufficient to teach students how to effectively apply sustainable design in professional practice [20], it is necessary to employ a learning method to let the students acquire the fundamental knowledge on the environmental problems and to verify it through their design projects. According to the author, the appropriate positioning of the sustainability issue within the interior design curriculum requires immediate and essential corrections within the educational program, as "the environmental dimension shifts from the status of a constraint, to a criterion" [21]. In the following sections, the author suggests an area of possible interventions on the interior design teaching scheme, resulting on the inclusion of the environmental context as a crucial design determinant.

3. The Areas of Modifications of Interior Architectural Design Teaching Schemes

For interior architectural design, identified as environmentally sustainable, to prove its ecological effectiveness, it should be based on a holistic approach. Since buildings' interior spaces directly mediates their occupants' experience, they remain a relevant part of the built environment, affecting users' health and well-being. It is necessary to make predictions regarding the possible impacts of interior settings on the natural environment, with which the inner spaces establish an indirect form of mediation. Interior architectural design is to recognize and then to respect this interrelationship by reducing the environmental cost of the completion of interiors associated with the excessive consumption of resources, emission of toxic chemical substances due to manufacturing processes, energy consumption to complete all phases of building process, as well as waste production.

To accomplish these objectives it is necessary to highlight the "environmental contextualization" [17,22] of constitutive interior components (i.e., formally and functionally remodeled internal sides of building envelopes, structurally and functionally developed space dividers). The above-mentioned environmental contextualization of forming interior components is defined as a design activity that integrates complex environmental aspects into the process of creation of interior spaces and their parts. Application of environmental context into the assessment of interior components enables their recognition as: (1) vast reservoirs of resources and embodied energy; (2) waste coming from the cyclical processes of construction, refurbishment, or demolition; (3) emitters of potentially harmful chemical substances influencing occupants' health and well-being due to off-gassing processes; (4) "integrated design instruments" [18] to improve the quality parameters of indoor environment. Thus, the environmental context should be then considered as the substantial design criterion, equally valued along with formal integrity, functional compliance, and aesthetic identity, that still form the main areas of concern within traditionally exercised interior design (Figure 1). The environment-oriented approach to the complexity of interior architectural design should be adequately exposed within the educational framework.

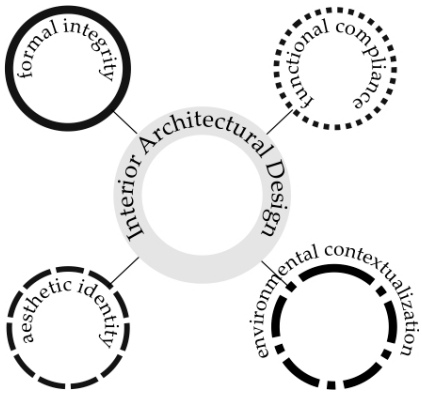


Figure 1. The environmental contextualization design criterion for the comprehensive model of interior architectural design. Source: author's drawing.

Gould claims that the interior design profession needs rational undergraduate training, continuing education opportunities, as well as support to provide research in sustainability, and suggests hiring "tenure environmental professionals as teachers" [23], among other solutions. This concept is in tune with the opinion that "schools of architecture, interior design and engineering should rewrite their mission statements" [23]. Meanwhile, learning objectives for interior architecture studies, contained within officially published materials by interior architectural design faculties affiliated with academies of fine arts, concentrate on developing selected design project skills. These are to allow students to define and formulate the basic principles and criteria for a given design project, as well as to evaluate an architectural work in terms of its location, cultural determinants, cultural environment, utility, construction, and aesthetics. The environmental sustainability in interior architectural design remains unrecognized within these aims, and is still not mentioned as a part of the educational mission.

As for the sustainability issue, "interior design educators must include this crucial component in curriculum to successfully inform the students" [16]. There are different methods to realize this postulate depending on the faculty's overall structure. The successful accomplishment of sustainability imperatives in interior design requires certain structural systemic changes [24], realized by knowledgeable and devoted educators.

The possible corrections to the curriculum, to assure the accomplishment of environmental sustainability issues in interior design, embed the main following intervention modes regarding the framework structure and content of delivered courses:

- Setting up an autonomous theoretical course on Environmentally Sustainable Interior Architectural Design based on lectures and seminars and conducted as a compulsory core course which serves as introduction, to provide students with "ecological literacy" [25];
- Integration of sustainability considerations across the interior design curriculum through the disclosure of problems related to environmental issues within design courses, core courses, and support courses;
- Execution of the adjusted educational program of selected courses, namely building construction based on: (1) adaptions regarding the placement of the building construction subject in the interior design curriculum; (2) the building construction course's substantial integration with other subjects; (3) identification of environmental and temporal contexts in which building construction issues should be delivered.

The changes in the ratio of course work dedicated to the environment-sustainability-oriented program to the overall curriculum seem difficult to realize in the nearest future. Therefore, alternative solutions to reform the teaching framework should be considered. The later hybrid model, concerning the adjustment of the content of technical modules toward a broad exposure of environment-responsibility, discussed later in the separate subsection, is one of these promising solutions.

The adjustments for the currently exercised interior architectural design curriculum concern the possibilities of integration of sustainability issues across the different teaching courses offered to the students. These discussed modifications, in terms of the inclusion of new design tools into the learning environment, encompass the following elements:

- Professional design tools founded on the professional quantitative and qualitative validation schemes, as supportive educational instruments in the educational process to evaluate the accomplishment of the sustainability paradigm in students' projects [22];
- Illustrative tools comprising environmental or resource drawings [26] and visuals [27], as integral elements of design development documentation to specify the sustainability features of internal spaces and their components;
- Building Information Modeling BIM, to change the design linear scheme into a virtual and cyclical model;
- Development of students' course design projects as contributions to the architectural competitions oriented to the assessment of projects' compliance with the environmental sustainability requirements and organized by institutions promoting green building.

Learning activities introduced to promote sustainability issues confirmed that the student-centered perspective applied to the teaching process should exceed the conventional course-based learning activity. With the focus on the environmental consciousness and responsibility in interior architectural design, they are to "seek affective outcomes that include a range of values, attitudes and behaviours" [8]. These comprise the following:

- Interdisciplinary design workshops including students of different specialties and faculties (e.g., architecture, mechanical engineering, electrical engineering, environmental engineering) to facilitate the transfer of knowledge between participants involved in a project;
- Group analyses of case studies of interiors;
- Design workshops and seminars with interior design professionals involved in practicing sustainable interior architectural design;
- Seminars with engaged experts, particularly accredited green building consultants [1].
- Integrative design classes conducted within practical modules of selected courses offered to interior architecture students.

In the further subsections, we discuss the results of adapting the environmental perspective to the building construction subject and the meaning of this adjusted core course for reforming the teaching framework, as well as the inclusion of certification schemes, visuals, and finally the integrative design classes as learning tools to solve sustainability problems.

3.1. Building Construction Positioning within the Teaching Program

The development of the educational program around the modified and environmental-sustainability-oriented course on building construction is to cover basic problems related to the realization of sustainable interior design goals. The identification of environmental and temporal contexts in which the leading building construction issues are delivered to interior design students is to be included in the education process.

This proposal seems promising and straightforward, considering that the building construction subject is present in the interior design curriculum, preceding the interior architectural design conducted within design studios. Therefore, it can effectively turn the attention of students to sustainability issues in their further design projects. The Building Construction course should be concentrated on the following: (1) studies on the interior structural and complementing components in relation to building systems and building components; (2) analysis of their impact on the development of interior spaces; (3) analysis of the material consumption-oriented results of the structural cohesion of inner space components and building components; (4) studies on the consequences of interior components adding

to the passive mode building systems' enhancement. The application of these strategies to the interior decision-making process is meant to emphasize that every inner space component should be designed as a conventional one, but with carefully employed sustainability features. These modifications, to comply with the sustainability imperatives in interior design proposed in this structural scheme, include the following: (1) building materials for sustainable interiors with a focus on the durability of materials and products, methods for material resource conservation, techniques for materials recovery and reuse, effective construction demolition waste; (2) building physics for sustainable interiors to highlight methods for the regulation of inner air humidity, daylight transmission endorsement, acoustic optimization; (3) building systems for sustainable interiors with a focus on the interior design methods for systems' enhancement.

These modifications within the program rely on the consequent and broad presence of environmental contextualization in design methodology. The classification of main building construction-related concerns that should be addressed in green building design are as follows:

- Comparative analysis of building materials and their parameters to identify the environmental preferences as the leading interior design decision-making factors;
- Simplified life cycle analysis of the building products and materials;
- Analysis of the properties of building materials and products and evaluation of their environmental cost as a decisive factor in making their specifications,

3.2. Professional Tools for the Validation of Design Projects' Sustainability

Among the professional tools to be included in the design process, the multi-criteria environmental evaluation, in conjunction with interdisciplinary students' workshops, is to significantly influence the design process. The solutions proposed by students can be enhanced with corrections made by external experts, namely green building consultants, based on measurements included into the certification systems' set of criteria.

As Sian Moxon claims, the "assessment and certification schemes offer a way for designers to formalize a sustainable approach to design" [28]. These tools, being the informal informative instruments for the professionals, can be implemented into the teaching framework as learning instruments to harmonize the validation of projects with the environmental sustainability paradigm.

The adaptation of the student interior design projects to the requirements of a complex environmental evaluation makes it possible to review their design proposals through a comprehensive pre-occupancy assessment. This tool should be adopted to the interior design education curriculum since the post-completion and post-occupation evaluation of students' interior design projects, as the majority of works completed by students is not carried out. The multi-criteria environmental evaluation systems (e.g., the WELL Building Standard building-rating system, focused on the enhancement of the health and wellness of inner spaces' occupants) [29] can be treated as reliable interior design education instruments regarding the conformity validation of design projects with sustainability requirements. The simplified multi-criteria evaluation enclosed within the framework make an integrating platform in the environmentally responsible interior design education model. This design tool is to change the interior design students' attitude toward their contribution to the decision-making process, and to turn the interior architectural design education methodology into an evidence-based and practice-oriented methodology. Students are, therefore, equipped with specific design tools to assure a scientific, objective estimation of the impact of their proposals on their surroundings and to provide them with a support for the analysis of inner spaces' environmental performance.

3.3. Illustrative Tools to Endorse Design Interventions

Visuals or environmental drawings concerning the sustainability features of interiors and their components can be defined as the additional illustrative and explanatory part of drawing sets, containing the information regarding design decisions made during the conceptual phase. Prepared by

students as integral elements of design development documentation, they are to explain the details of interior design proposals as regards the buildings' surroundings, their interior space systems' solutions, overall building energy, as well as natural ventilation concepts. These graphic tools clarify to the students the possible interaction and interconnectedness between natural and indoor environments, to:

- Articulate the complexity of interiors' environmental responsibility in the sustainable interior design model;
- Indicate the sustainable strategies to be accomplished in the process of interior design along with functional, spatial, and formal demands.

The exemplary sustainability features to be demonstrated with the environmental drawings developed by the students, and referring to the material specification, resources management issues, as well as positioning components as sustainable design instruments, include the following:

- "Intra-setting adaptive reuse" [18] of selected interior components specified in the design concept documentation, with emphasis on their material content and methods of construction, enabling their future dismantling and reclaim;
- Indication of materials and products to be collected on a daily basis, in order to be recycled, and location of spaces designed to store recycling containers;
- Environmental activation of constitutive interior components and its impact on the enhancement of building systems' performance (e.g., partitions or internal walls introduced as thermal storage walls for the minimization of heating energy consumption).

Environmental drawings are supplementary databases to the conceptual phase, as well as supportive tools for students of different specialties involved in an interdisciplinary design team. Visuals in the interior design documentation can explain the meaning of sustainable issues in architectural design, and are another valuable educational tool concerning the environment-oriented components' creation and related inner space, as well as resource management. These drawings provide a visualization of the ecological efficiency and energy-cost effectiveness of interiors as "keyed to sustainable features" [26], to help the students understand the interior components' role in the environmentally conscious forming of inner spaces.

Modifications to create the teaching framework addressing environmental considerations in interior design concern the conjunction of an environment-effectiveness-oriented modified building construction course and a cycle of theoretical lectures covering sustainable architectural design issues, to create a more "engaging learning environment" [30] around the innovative integrative design classes.

4. Integrative Design Class (IDC) for Environmentally Responsible Interiors

Sorrento claims that educators will need to change "how to teach students to participate in the integrative design" [31], and to accomplish the environmentally sustainable postulates. The successful accomplishment of sustainability imperatives in interior design requires certain structural systemic changes [24]. Since there are difficulties with the corrections of well-established educational frameworks, there is place for innovative solutions to remodel the existing scheme within limitations. The author's proposal is based on the innovative concept of cohesive educational program. It is built around the environment-effectiveness-oriented compulsory subject Building Construction and a cycle of elective lectures on Environmentally Sustainable Architectural Design with integrative design classes. These are the instruments to assure the practical implementation of this educational model and to facilitate the future applications of sustainability guidelines by students in the projects worked out in design studios. The condition for the successful accomplishment of this concept is the cohesiveness of the substances of these subjects (Figure 2) and the focus on the design methodology outlining environmental requirements as substantial design guidelines.

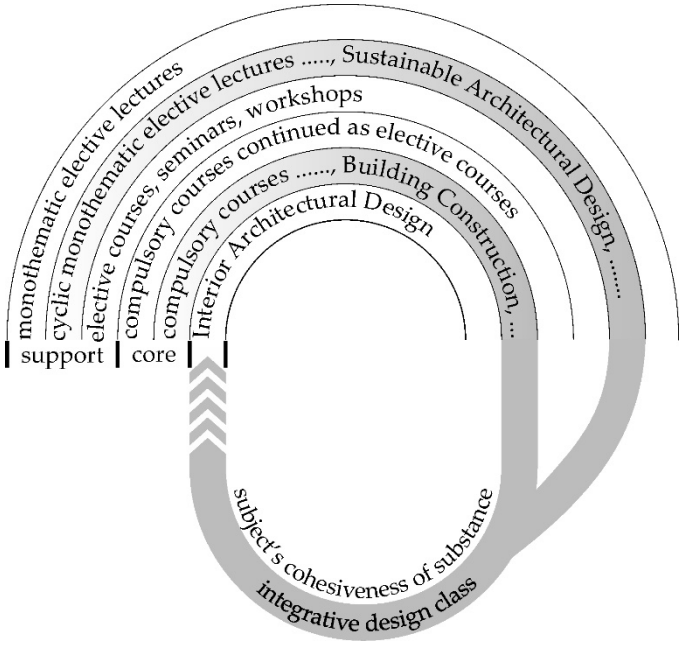


Figure 2. Building construction and lecture course on the sustainable architectural design cohesiveness of substance as the basis for the integrative design classes preceding the design studios program. Source: author's drawing.

The integrative design class, as a practical application of the previously suggested modified program of building construction, is a means to develop a creative learning environment and a complementary educational tool to realize the specific and sustainability-related themes covered by the two analyzed courses. This concept of active learning setting differs from the standard classroom environment that dominates the conventional educational model, in terms of developing the design process skills, as well as changing the student-teacher interactions. The students, working on their projects individually, systematically present the progress in their projects' development to other participants of the integrative design class through oral presentation. Open discussions over their proposals are to replace the conventional means of critique by the educator.

Integrative design class, with the design project as its practical component, is to provide students with knowledge and abilities to make the informed design decisions, in particular to: (1) consider the environmental criterion concerning the shaping of interiors and their components; (2) recognize the "project–related research" [32] and conduct appropriate inquiries on "research by design in interior architecture" [33]. The concept of an integrative design class is an example of an active, supportive project-based learning technique that reveals a different educational approach and perspective. It emphasizes the development of the design process to reduce the negative phenomenon of paying excessive attention to the end-product, while ignoring the design procedures by the students [34]. The concept specifies the learning objective to strengthen the students' ability to accomplish sustainable design strategies and develop interior spaces with a high environmental performance.

4.1. Methodology

The main objective of the conducted study was to introduce an integrative design class into the interior architectural design teaching process, to verify the possible benefits of its inclusion, to recommend this learning tool as a means to adjust the teaching framework addressing the sustainability issue.

In both assignments, students were to follow the environmental-sustainability-oriented strategies discussed within the cycle of lectures on sustainability issues. They were to introduce innovative design intervention modes into the existing spatial structures to assure a decrease in the negative environmental

impact of interior spaces, while forming healthy working and learning settings with high indoor environment quality parameters partially resulting from a conscious material specification—all this in accordance with the definition of sustainable interior design practice, recognizing its three dimensions, namely global sustainable interior design, indoor environmental quality, and interior materials [35].

The design process was preceded by class discussions and analyses of related case studies on the contemporary models of modern co-working spaces and learning spaces, realized within selected higher education facilities. The design research methods used by the students to guide design decisions comprised literature reviews and pre-design observations including the participatory observations within the existing spaces of similar functional demands. These were to familiarize interior design students with the meaning of practicing the Evidence-Based Design model within their discipline [36].

The students participating in these integrative classes were encouraged by the educator to apply different modes of presentation to their design projects. These methods comprised: (1) conceptual sketches to give an overall idea of the projects, with emphasis on the educational and behavioral aspects of the designed setting and interior components; (2) building drawings to explain technical aspects of the proposals, with emphasis on their compliance with the sustainability requirements; (3) visuals to explain the environmental context of interior components to encourage occupants' (i.e., workers, students, visitors) involvement in sustainable practices; (4) schemes and diagrams to illustrate the functional and spatial relationship between adjacent spaces; (5) perspective drawings.

An integral element of these studies were surveys based on open-ended, close-ended, and descriptive questionnaires conducted among participating students. The questionnaires were to examine students' level of environmental concerns and sustainability knowledge, prior to their enrollment into the elective cycle of lectures on environmentally sustainable architectural design, and after these lectures preceding the integrative design classes. The students were asked to indicate if the design methods oriented on resource effectiveness had increased their interest in the accomplishment of other sustainable postulates, and changed their personal attitudes toward the justified consumption of building products to complete interiors. They were asked to assess the employed design methods as efficient means of control over materials consumption, and thus determine whether it was worth recommending them to other designers. The subject of the descriptive part of this questionnaire were the outcomes of the inclusion of resource effectiveness postulates as design determinants into the interior design process.

The students were to identify different types of users' activities to be realized within the designed spaces, and then to indicate the specific environment-related problems that could be solved in line with the functional and formal demands. They were questioned about the inclusion of the postulate of occupants' pro-environmental education into the interior design methodology. They were also asked to assess the significance of the environment-responsibility-oriented stimulation of users' behavior through interior design, the range of technical means to realize this postulate in practice, as well as their effects on the formal appearance of interiors, defining the interiors' eco-aesthetics.

4.2. Case Study

The pilot integrative design class was carried out in the 2018/2019 academic year, and then continued in the summer semester of the 2019/2020 academic year, within the obligatory course on Building Construction. The selected groups of six students, out of the total number of 22 third-year undergraduate interior design students, who were attending the facultative lectures on sustainability in architectural design, were invited to develop their semester design projects within the project-learning module of the Building Construction course and the practical module realized within the cycle of elective lectures on Environmentally Sustainable Architectural Design.

The subject of the students' design projects realized within the pilot integrative class was the development of a co-working space assigned to selected start-ups (e.g., consulting, interior design, real estate), and situated in an existing commercial center. Students were to develop a design concept for activity-based flexible office spaces [37], in conformity with sustainable demands for optimization

of the psycho-physical comfort of occupants, by facilitating different forms of the exercised working methods (e.g., informal meetings, individual conceptual work, private phone calls, creative workshops, presentations), as well as for the densifying use of interior spaces "to encourage their greater co-use" [37].

The main objective of the pilot class was to enable the interior design students' recognition of sustainable design strategies for resource efficiency and waste management effectiveness as leading design guidelines. Students were encouraged to investigate the position of a proposed concept for Design for Resource Efficient Interiors (DfREI) [1] based on their design projects, in accordance with the sustainability postulate, and to search for the eco-aesthetics of inner spaces, deriving from the eco-design's "focus on the whole life-cycle of products", as well as on the "product's social impacts" [38]. The detailed objective of this study was to develop design methods to fulfill the DfREI framework while assuring the flexible, functional, and promising high-quality parameters of the working environment and its structural components.

The following academic year, another group of 10 students out of the total number of 28 third-year undergraduate interior design students worked on a project for a student study space, featuring the main part of the "learning neighbor" [39]. This study space was assigned to function within a remodeled higher education facility. It was to offer interior design students a space to informally continue their learning procedure, apart from the regularly scheduled classes, through different learning activities (e.g., networking, multimedia presentations, group work, individual studies, discussions, design workshops). Students were encouraged to develop their design projects, with the following aims: (1) complying with the sustainability demands; (2) exploring the environment-oriented educational aspects of interior design; (3) encouraging "desired circular behaviours" [40] among occupants through the implementation of unconventional design methods and techniques, to enable users' adoption of pro-environmental behavioral schemes.

The main objective of this edition of the integrative design class was to employ the concept of Design for Sustainable Behavior (DfSB) [41,42], based on reducing its negative impact on the natural environment, caused by the unreflective conduct of buildings' users, as well as to persuade the occupants to behave in a more environmentally responsible way through the carefully designed products. Since interior components make for structurally, formally, and functionally developed products, this concept can be applied to their creation process. The projects were to influence the users' perception of the emotional and cognitive levels, since "users have to make the link between the information, their own behaviour and the environmental and social impact" [43].

The detailed objectives of this integrative class were as follows:

- Development and application of modified design methods and tools to create interior components as instruments to promote occupants' environmental awareness;
- Rise of the users' interest in exploring the environmental context through the interior components' appearance;
- Stimulation of the end-users' pro-environmental behavioral attitudes and habits through the interior's spatial layout and the shaping of multi-functional structures.

The latter was to confirm the statement that the "application of sustainable design can greatly reduce the environmental and social impacts" [43] of services, as well as products. With the recognition of interior components as formally developed building products, this opinion is of great importance for interior architects.

4.2.1. Design Techniques in the Design Brief

The co-working open space proposed by the students was concentrated on the human-centered strategy for the optimization of interior space parameters, in terms of optical, acoustical, and psycho-physical comfort.

The exemplary design techniques developed by the students working on the project of the study space, with the aim of incorporating active design elements into the spatial layout, comprised the following:

- Spatial layout to address the functional zoning;
- Supplementary informal meeting rooms situated within circulation areas and separated from the adjacent places by multi-functional space dividers;
- Biological walls integrated with partitions to accomplish the biophilia concept;
- Standing desks to complement the traditional arrangement of workstations;
- Treadmill desks and exercise balls used as desk chairs to address innovative ways to improve the quality of workers' physical comfort;
- Recreation and relaxation areas within open students' study space, formed with the structurally developed parts of the raised floor.

The learning environment functioning within the higher education facilities offers the interior architects an opportunity to explore the educational aspects of designs and to modulate the end-users' conduct. The exemplary design techniques developed by the students working on the project of the study space, aimed at promoting the occupants' sustainability awareness and to stimulate their pro-environmental attitudes, were the following:

- Selection and broad exposition of certified building materials with the use of appropriately introduced graphic tools;
- Exploration of the concept of "truth windows" in forming of interior components to provide users with information on the physical characteristics of selected building materials, to explore the educational aspects of the sustainable design of built environment [44];
- Exposition of the ecologic infographic as an integral element to shape the interior components' structure.

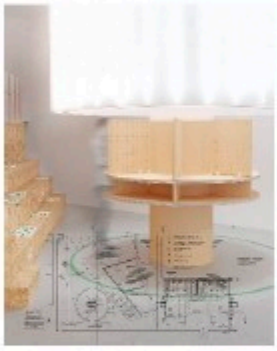
Figure 3 presents the selected design methods developed and applied by the students to achieve the main goals of the design projects.

4.2.2. Environmental Strategies and Means of Interior Design Intervention

The interconnectedness of the natural and built environment components is seen as an essential design environmental-responsibility indicator of an interior and its components. Design interventions, oriented toward the control over building materials and product consumption level, are crucial for the creation of sustainable interior components. The most effective and technically affordable methods to fulfill this demand, embedded in the concept of DfREI and executed in the students' design projects, combined the following: (1) Design for direct control and reduction of resource consumption; (2) Design for deconstruction and disassembly [45] adjusted to the formation and scale of interior constitutive components; (3) Design for direct reuse or adaptive reuse, exercised within the interior design discipline, in intra- as well as inter-setting contexts; (4) Design for repair and upgrading services; (5) Design for recyclability, and with the usage of recycled building materials.

- Design project
  - Exemplary interior architectural design techniques

- Co-working open space
  - Biological walls integrated with partitions or workstations to accomplish the biophilia concept;
  - Spatial layout to address the functional zoning;
  - Supplementary informal meeting rooms situated within circulation areas and separated from the adjacent places by multi-functional space dividers;



- Co-working open space
  - Spatial layout to address the functional zoning;
  - Standing desks to complement the traditional arrangement of workstations;
  - Interior components forming acoustic buffers introduced to avoid distractions;

- Students' study space to supplement the learning environment
  - Spatial layout to address the functional zoning achieved with mobile panels;
  - Exposition of the ecologic infographic as an integral element to shape the interior components' structure;
  - Recreation and relaxation areas to buffer individual stressors formed within the study space through the structurally developed raised floor

Figure 3. Integrative design class learning tool to exercise design methods to accomplish the design brief (3rd year undergraduate students: P. Pasztaleniec, K. Milchina, A. Jędryka; supervisor: M. Celadyn, source: Archive of the Faculty of Interior Design, *Jan Matejko* Academy of Fine Arts in Krakow).

Students' proposals recognized the effectiveness in resource management as a critical design criterion and comprised the following exemplary design interventions, that prove their efforts to exercise "sustainable design thinking" [46] (Figure 4):

- Dematerialization, understood as a substantial decrease in the amount of used resources to complete interior components without deterioration of their functionality;
- Reduction in the amount of finishing materials used to complete components with exposed materials' structure;
- Adaptability of space through the broad introduction of mobile or demountable structures;
- Multi-functionality of the constitutive (e.g., structurally developed space dividers, seats) or supplementing (e.g., containers for office stationery, furnishing) interior components;
- Flexibility of interior components accomplished with modularity and adjustability in volume;

- Assembling techniques of components' parts that condition their dismantling for further modernization or reuse in other spatial or functional contexts;
- Specification of materials with a low degree of processing, and decrease in the usage of composites to facilitate their further reuse;
- Adaptive reuse of reclaimed building materials and products acquired from the refurbished or demolished inner spaces, with their implementation into the newly formed interior components' structures;
- Reintroduction of post-consumer and post-production waste into the substance of constitutive interior components.

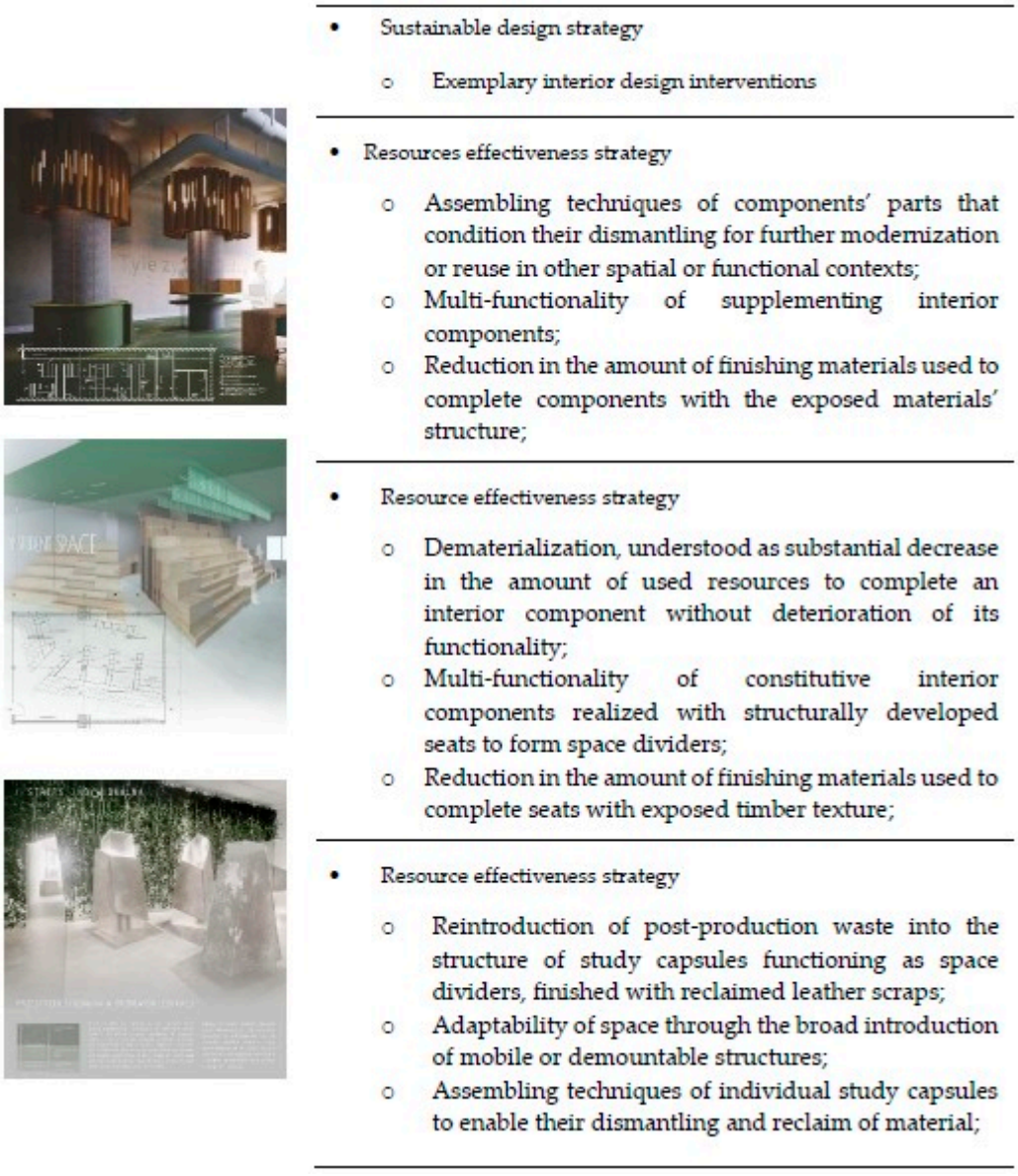


Figure 4. Integrative design class to exercise the sustainability-oriented design interventions in shaping the interior environment (3rd year undergraduate students: P. Chrzanowska, K. Garus, W. Wawro, A. Burzec, W. Ządło, A. Łapa; supervisor: M. Celadyn, source: Archive of the Faculty of Interior Design, *Jan Matejko* Academy of Fine Arts in Krakow).

The exemplary innovative and pro-environmental design techniques proposed by the students in both projects, to address the primary design guidelines and to get the high environmental performance of interior spaces in terms of physical comfort, comprised the following solutions:

- Space layout and interior components' volumes enabling undisturbed daylight transmission;
- Interior components forming acoustic buffers to reduce the sound transmission and assure an appropriate level of speech privacy and selection of sound absorbing finishing building materials to reduce reverberation time;
- Finishing interior components in bright colors to promote deeper penetration of daylight coming from the glazed external wall of the adjacent circulation area;
- Interior components formed as visual buffers adjusted to the occupants' sitting position and introduced in order to avoid distractions;
- Integration of biological walls with the structure of selected interior constitutive components to help control the inner air's relative humidity and temperature, as well as to provide users with acoustic comfort.

There were some proposals to let some spaces be organized independently by the occupants, by reintroducing reclaimed furnishing or equipment, according to the designers' suggestions and technical assistance, along with innovative concepts to actively promote the environmental questions and promote the occupants' awareness of the positive influence of their sustainable behaviors.

4.2.3. Perception of Environmental Postulates in Interior Design

The main purpose of the survey conducted within this study was to examine the impact of the knowledge on sustainability issues attained from the lectures and then exercised within classes, on students' perceptions of these problems and motivation to apply them as crucial determinants in designing indoor environments.

In the first section of the survey, common to the two integrative design classes conducted in consecutive academic years, the students were to rate their understanding of sustainability issues, prior to their enrolment in the elective cycle of lectures on environmentally sustainable architectural design. Then, they were to respond to the questionnaires given after the introductory theoretical lectures to evaluate their subjective knowledge [47] on sustainability, acquired within the lecture course.

5. Discussion

A few currently exercised teaching programs within faculties of interior architectural design in Poland offer autonomous courses on environmental sustainability, concentrating on the fragmented and incomplete implementation of this question into the core and design courses. This is despite the rising awareness of sustainability themes among clients, occupants, as well as practicing interior designers. The inclusion of professional design tools as learning tools and the promotion of new learning activities based on the integrative design aim to facilitate the implementation of these postulates into the currently employed interior design curriculum. Interior architectural sustainability-related requirements can be identified as incentives for an innovative search for the aesthetical identity, functional conformity, or formal integrity of inner spaces and their components.

In the main descriptive section of the questionnaire completed by the students attending the pilot integrative design class, the participants identified as mostly beneficial the following outcomes of the exploration of the resource efficiency strategy in the design projects prepared within the integrative design class: (1) overcoming of some uncertainties or misinterpretations concerning the position of the interior design discipline in the reduction of the negative impact of the built environment on the natural one; (2) recognition of the resource-related postulate as a design guideline for formal, technical, and functional cohesion; (3) promotion of abilities to creatively implement sustainability principles.

The findings of the survey section accompanying the study space development revealed the students' interest in: (1) the implementation of professional design methods and tools including green

building materials certification systems, to complete constitutive interior components, as well as complementing them; (2) the integration of sustainable features into the structure of interior components and their exposition as indirect educational tools to promote occupants' environmental consciousness; (3) the adoption of an environmental perspective in the creation of inner spaces' components, in a search for innovative design solutions.

The results of the students' design projects, as well as the remarks enclosed in the questionnaires, confirmed the students' interest in: (1) considering the environmental issues while forming interiors; (2) understanding the importance of these matters becoming substantial design criteria; (3) noticing the formal potential of the integration of sustainable features into interior architectural design. In particular, these results confirmed the students' commitment to consider environmental issues while forming interiors, and their positive reflections on the interior architects' active role in the stimulation of pro-environmental behavioral schemes among the occupants of buildings.

The study has revealed the integrative design classes, conducted for the interior design students on the basis of a compulsory course on Building Construction and facultative lectures on Environmentally Sustainable Architectural Design, as a driver for developing technically and formally innovative design solutions, as well as an inspiring research-through-design educational method. Integrative design classes allowed the students to establish a link between theoretical knowledge on sustainability in interior design and its practical implementation, through the development of unconventional technical and material proposals. These classes proved their ability to incorporate environmental considerations, in a complex and systemic manner, into the interior architectural design curriculum.

6. Conclusions

The integrative design classes incorporated into the existing conventional educational framework, offered the interior design students: (1) a platform to build up the buildings' occupants' awareness of the impact of their behavioral attitudes and habits on the natural environment, as well as on the building's environmental performance; (2) a model for shaping interior components recognized as determinants of the buildings' users' environmentally responsible conduct; (3) a learning tool to gain the ability to implement creative, innovative, and evidence-based sustainability issues into design projects.

The integrative classes discussed in this paper, can be treated as supportive instruments in the transformation of the learning process toward a conscious and complex exploration of environmental and temporal contexts within interior architectural design, with a research-through-design project execution. This educational tool aims to modify the design methodology exercised within design studios and to strengthen the effect of environmentally sustainable architectural design elective lectures on the perception of the complexity of the subject of sustainability on the part of interior architectural design students. It aims to facilitate the future applications of sustainable design guidelines in the design projects developed within design studios, particularly final diploma projects.

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