Aportes de la metodología de aula invertida en el proceso de enseñanza-aprendizaje de la arquitectura bioclimática
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CONTRIBUTIONS OF THE INVERTED CLASSROOM METHODOLOGY IN THE TEACHING-LEARNING PROCESS OF BIOCLIMATIC ARCHITECTURE

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APORTES DE LA METODOLOGÍA DE AULA INVERTIDA EN EL PROCESO DE ENSEÑANZA-APRENDIZAJE DE LA ARQUITECTURA BIOCLIMÁTICA

CONTRIBUIÇÕES DA METODOLOGIA DA SALA DE AULA INVERTIDA NO PROCESSO DE ENSINO-APRENDIZAGEM DA ARQUITETURA BIOCLIMÁTICA

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RESUMEN

La educación se ha transformado debido a las tecnologías. Por lo cual, más que compartir el conocimiento, se busca promover la creatividad desde herramientas y métodos. El objetivo del presente documento es analizar la idoneidad del aula invertida en el proceso de enseñanza-aprendizaje de la arquitectura bioclimática en contexto de pandemia o enseñanza tradicional presencial. La metodología tiene un enfoque cualitativo, diseño no experimental, y estudio exploratorio. Los resultados confirman que los alumnos dedujeron los conocimientos teóricos y las competencias que habrían recibido de manera lineal en el aula tradicional. Como conclusión, se plantea que la diferencia de esta práctica docente respecto a la tradicional estuvo en hacer que lo teórico deviniera de lo práctico, accionando un proceso de transposición didáctica que no sólo simplificó los saberes, sino que se apoyó en generar transversalidades desde las variables que integran el proceso de aprendizaje.

Palabras clave
arquitectura bioclimática, educación, aula invertida, proyectos, arquitectura vernácula, arquitectura sustentable

ABSTRACT

Education has changed thanks to technology. Therefore, more than sharing knowledge, the aim is to promote creativity through tools and methods. This paper aims at analyzing the suitability of the inverted classroom in the teaching-learning process of bioclimatic architecture in the context of a pandemic or traditional classroom teaching. The methodology has a qualitative approach, a non-experimental design, and an exploratory study. The results confirm that the students deduced the theoretical knowledge and competencies they would have received in a linear way in the traditional classroom. In conclusion, it is suggested that the difference between this teaching practice and a traditional one was in making the theoretical derive from the practical, activating a didactic transposition process that not only simplified knowledge but was based on generating transversalities from the variables involved in the learning process.

Keywords
bioclimatic architecture, education, inverted classroom, projects, vernacular architecture, sustainable architecture.

RESUMO

A educação tem passado por transformações devido às tecnologias. Mais do que compartilhar conhecimento, busca-se promover a criatividade por meio de ferramentas e métodos. O objetivo deste documento é analisar a adequação da sala de aula invertida no processo de ensino-aprendizagem da arquitetura bioclimática em contexto de pandemia ou ensino tradicional presencial. A metodologia adotada possui abordagem qualitativa, design não experimental e estudo exploratório. Os resultados confirmam que os alunos assimilaram os conhecimentos teóricos e habilidades que teriam adquirido de forma linear na sala de aula tradicional. Como conclusão, argumenta-se que a diferença dessa prática docente em relação à tradicional está em fazer com que o teórico se torne prático, ativando um processo de transposição didática que não apenas simplificou os saberes, mas também se apoiou na geração de interdisciplinaridade a partir das variáveis que compõem o processo de aprendizagem.

Palavras-chave
arquitetura bioclimática, educação, sala de aula invertida, projetos, arquitetura tradicional, arquitetura sustentável.

INTRODUCTION

Young university students no longer see technological advances as novelties, but as part of their daily life, now inhabited by digital tools that allow them to access and share information all the time, rethinking the modern concepts of time and space (Albarello, 2016). Daura and Barney (2016) state that teachers should identify activities that promote greater creativity and give students greater autonomy to learn (UNESCO, 2019).

This paradigm shift requires a change in teaching-learning strategies, because, as Soriano and Aguilar (2018) well reference, students are now "digital natives". In this regard, Perilla (2018) mentions that today's students need to find challenges and a sense of usefulness to the contents.

In this sense, the flipped classroom is a teaching method whose objective is to give the student a more active role in their learning process (Berenguer, 2016). Its dynamics lead to students studying the theoretical concepts provided by the teacher on their own. In this way, "learning by doing" is applied (González & Yanacallo, 2020) as a principle that, translated into instructional design, leads to a conversion of the units and contents of the subject around statements, which, as hypotheses, must be verified or refuted by the student through research and exemplification.

However, architecture teaching is traditionally structured around the "process of acquiring knowledge to understand and solve certain types of problems or situations" (Saldarriaga, 1996, p. 70), which comprises the epistemological space of architecture, namely, specific knowledge of the area and diverse knowledge produced in the heteronomy of its practice (Campo, 2018).

This has become a problem capable of transversally articulating the teaching-learning process of architecture at an undergraduate and postgraduate level, approaching the architectural project from the environmental conditions (Restrepo, 2013). Most architecture schools have included the relationship between architecture and the environment in their academic curricula to "promote knowledge and skills in sustainable environmental design, with the aim of achieving comfort, pleasure, well-being, and energy efficiency in new and existing buildings" (Almonte *et al.*, 2012, p. 3). In this way, the purpose of this article is to analyze the suitability of a flipped classroom in the bioclimatic architecture teaching-learning process in the context of the pandemic or traditional face-to-face teaching.

METHODOLOGY

This qualitative research was based on the flipped classroom model (Berenguer, 2016), to achieve a deeper perspective that would allow contextualizing the reality of the teaching-learning process of bioclimatic architecture in the context of the pandemic or traditional face-to-face teaching in the Master's Degree in Architecture and Urbanism (MAU) at the Universidad del Valle. A non-experimental-based research and exploratory study design were used in this research.

To carry out the research, the subject was divided into four workshops that would become modules for discovery and experimentation.

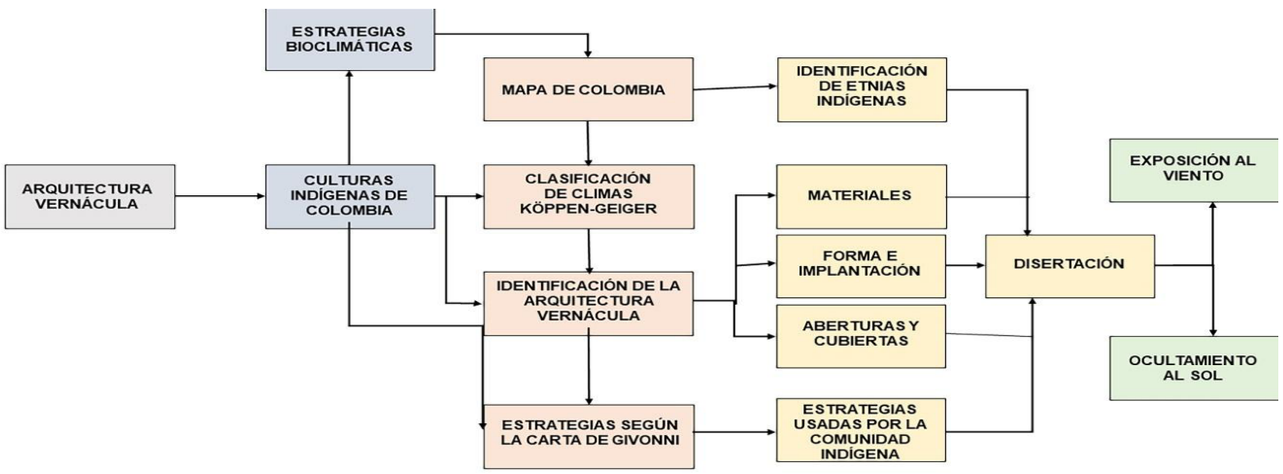

Figure 1. Diagram of Workshop 1. Source: Preparation by the authors

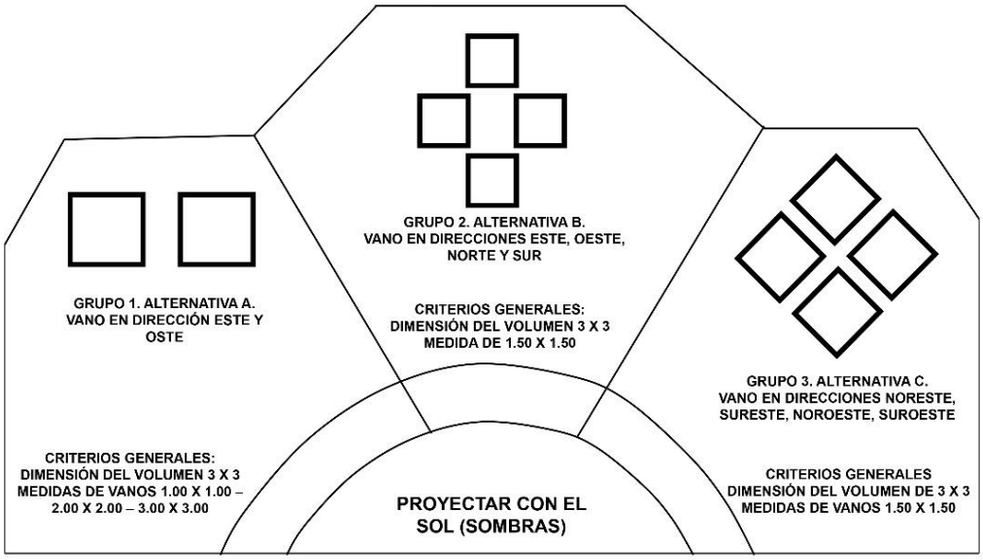

Figure 2. Diagram of Workshop 2. Source: Preparation by the authors

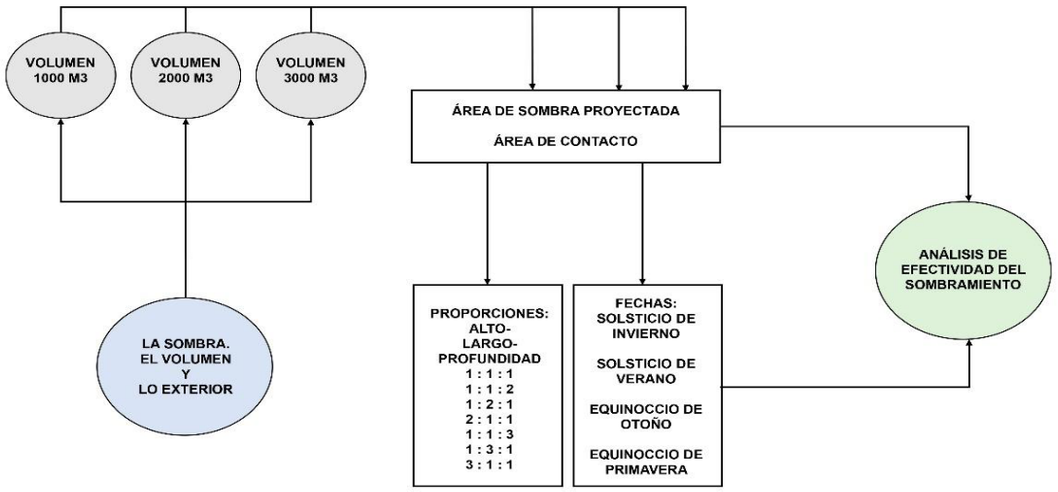

Figure 3. Diagram of Workshop 2.1. Source: Preparation by the authors

WORKSHOP 1: VERNACULAR ARCHITECTURE

The analysis of another country's vernacular architecture was put forward, in this case, Venezuela. With this reference, it was shown, first of all, how the forms of construction of each of the ethnic groups studied in this territory, had an architecture that is related to the environmental conditions (Philokyprou, 2011). Subsequently, it was demonstrated how these aspects were considered in their buildings (Figure 1).

WORKSHOP 2: SUN

This began by exchanging knowledge on topics such as the translational and rotational movement of the Earth and its relationship with building envelopes. Subsequently, a first task was assigned to the students, which consisted of defining a form of solar protection for a window with a specific orientation (Figure 2). In the second part of this workshop, emphasis was placed on shading projection in outdoor spaces through built volumes (Figure 3).

WORKSHOP 3: WIND

This began with an explanation of the principles that produce air movement and how some building examples manage to take advantage of it. The models used in the study of shading were used for calculations and simulations, whereby the students were able to analyze the behavior of airflow and air movement considering the location and size of the window (Figure 4).

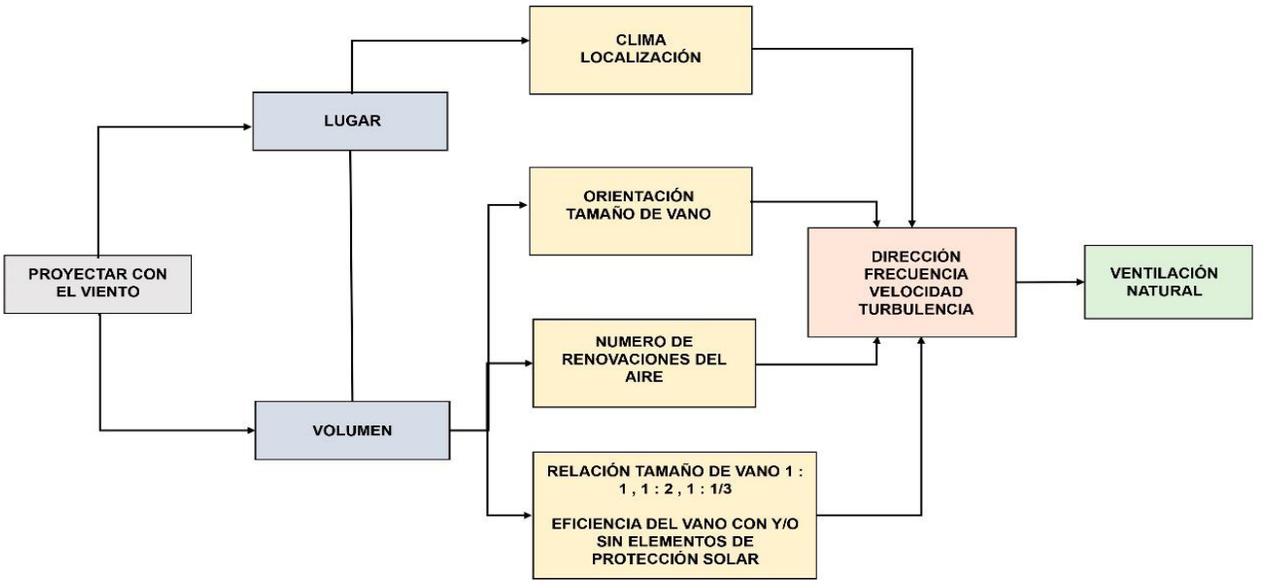

Figure 4. Diagram of Workshop 3. Source: Preparation by the authors

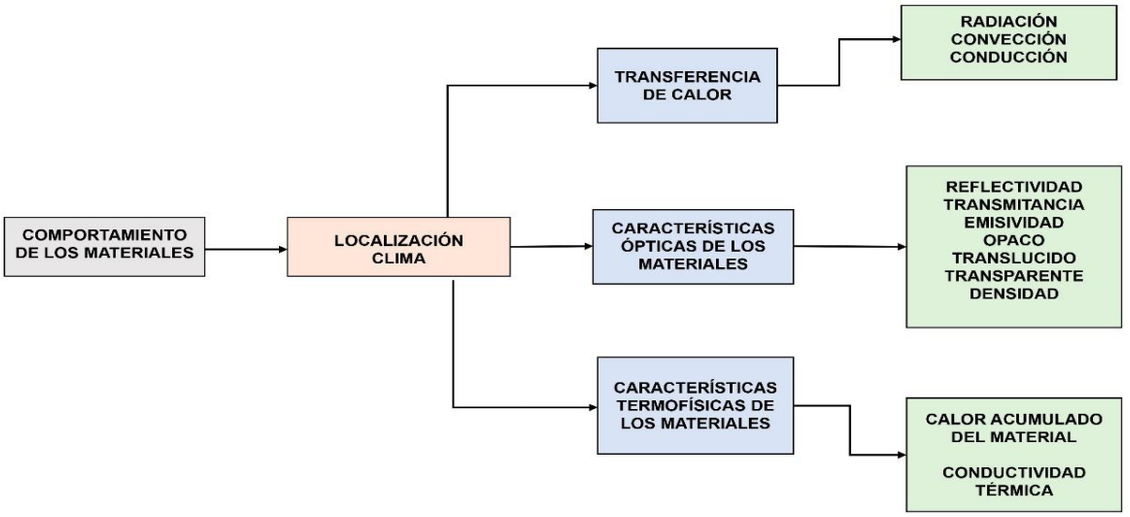

Figure 5. Diagram of Workshop 4. Source: Preparation by the authors

WORKSHOP 4: THERMODYNAMICS OF MATERIALS

This workshop was mediated by the concepts that define the physical and thermal properties of materials. Hence, it was proposed to analyze the behavior of the indoor hourly temperature using high, medium, and low-density materials, with and without insulating material (Givoni, 1969). For this, a database programmed in Excel was used (Neila, 1997) that allowed making analyses, which later the students had to use to interpret the temperature and time values (Figure 5).

EVALUATION OF THE METHOD AND ANALYSIS OF THE RESULTS

To evaluate the performance and quality of the didactics in the workshops taught, three techniques were used: the first, a peer evaluation of the process, which was done at the end of the workshops (providing a meta-evaluation and a hetero-evaluation of the experience); the second, was a semi-structured interview made individually to the students.

The peer evaluation was done internally and externally using the 2 teachers who taught the subject as an

internal jury and, as an invited jury, 4 external teachers were included in MAU. They attended as evaluators at the end of each workshop, and alongside presenting their feedback to the participants once the activity had finished, shared their assessments through a semi-structured interview.

The second strategy used, the semi-structured interview, was applied to the 8 students enrolled in the subject, as a structured survey, through a census sampling. In it, each of the suitability indicators was evaluated in simplified and general terms through a conversation, to capture a general appreciation that allowed the student to share the elements that had been most relevant within the process without being led by a pre-established script.

Finally, to define the adequacy in the other five indicators, once the subject was completed, an online questionnaire was applied with a Likert grading scale. Five levels were established from lowest to highest, using a numerical scale to measure attitudes: 1 (strongly disagree), 2 (disagree), 3 (neither agree nor disagree), 4 (agree), and 5 (strongly agree). The average is taken from this scale as a reference value since consistent levels were expected in the participants' assessment.

As mentioned previously, a census sample was made that covered all the students in the course, so this figure is simultaneously for the universe, sample, and population.

In these instruments, six didactic suitability dimensions were evaluated using the components proposed by Godino, 2017 and Godino, 2013:

- Epistemic suitability: Estimates the learning achieved compared to traditional models.
- Cognitive suitability: Evaluates whether the objectives set were achievable compared to the students' previous knowledge and if they were achieved at the end of the course.
- Interactional suitability: Establishes whether the interactions with the teacher are solving the students' doubts and difficulties and are favoring the learning process.
- Mediational suitability: Analyzes the adequacy of the resources used in the pedagogical process, involving time, technologies, and materials.
- Affective suitability: Evaluates the student's interest, motivation, involvement, and participation during the learning process.
- Ecological suitability: This was useful to estimate the adequacy of the educational process in the institution's educational project, the study curriculum, and the social and professional environment.

Semi-structured interviews were used to process the experience assessment instruments, as inputs to evaluate and design the aforementioned questionnaire. In addition, the assessments made by peer reviewers and the individual students allowed making a qualitative assessment of the experience in broader terms, particularly regarding epistemic and ecological suitability.

TEACHING-LEARNING OF BIOCLIMATIC ARCHITECTURE AT THE SCHOOL OF ARCHITECTURE OF THE UNIVERSIDAD DEL VALLE

MAU offers an architecture and bioclimatic urbanism line of work where the thermal comfort of users and the use of climatic conditions of the place are studied (Olgyay, 1963). The teaching-learning process in the Architecture and Bioclimatic Urbanism course at MAU has been oriented towards competence-learning, which dictates that to achieve the performance levels of a given competence, a set of evidence and indicators of achievements must be met.

In this sense, the achievements in the subject's teaching-learning process are translated into generating different experiences so that the student becomes the protagonist of their educational process through the transformation of didactical strategies, which targets a resignification of the processes inherent to the classroom. By getting students to become protagonists of their learning, the pace of the process takes on a personal dimension, and a personal learning environment (PLE) is generated (Vidal, 2015). Thus, students with functional diversity can take advantage of the possibility of developing certain aspects or repeating content at certain times.

Aguilera-Ruiz et al. (2017) take stock of this and refer, in addition to the advantages already mentioned, to the drawback in that this modality involves an additional effort for the teacher than the traditional method, as well as point out the resistance that students can express to it.

To materialize this modality, the course is structured under the following premise: the theoretical becomes practical. That is, during the subject, a process of didactic transposition is activated as a strategy that not only simplifies the assimilation of knowledge for the student, but also relies on the generation of transversalities from the elements involved in the learning processes: actors, channels, means, and didactic sequences (López-Gutiérrez & Pérez-Ones, 2022).

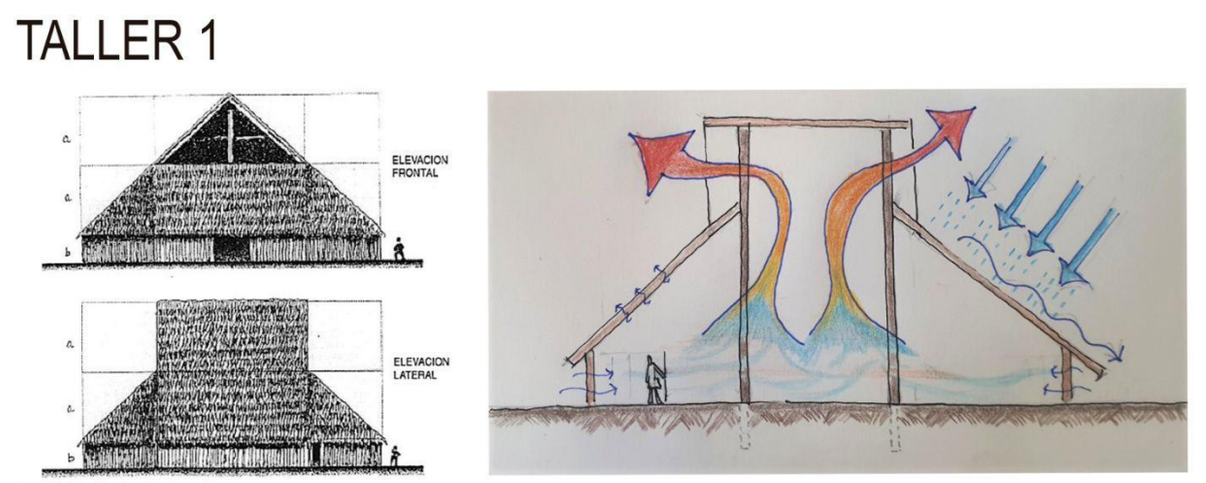

Figure 6. Processes and results of the workshops. Source: Preparation by the authors

In the application of this model during the global health crisis caused by Covid-19, the flipped classroom (Janssen, 2020) became an approach to be considered, as Williner (2021) and Cornelis (2020) confirm, as it does not require the physical presence of the teacher. However, although this methodology is an opportunity for the student to assume the limelight, it also entails that both the institution and the professors assume a greater burden.

RESULTS AND DISCUSSION

ASSESSMENT OF DIDACTIC SUITABILITY

The flipped classroom was proposed during the health contingency to take advantage of the context to generate a resignification of learning. Based on the investment this change of approach implies, the student must independently work, study, and analyze the theoretical concepts that the teachers provide.

By structuring the course into workshops and not programmatic content, so that the learning of bioclimatic architecture was generated from the real to the abstract, it was considered that it was not so necessary for students to have specific prior knowledge to understand the exercises and, in addition, the possibility of grouping students beyond their level of studies was opened. This new organization meant a strengthening and creation of new synergies between undergraduate and postgraduate students, through the promotion of collaborative work, the construction of critical knowledge, exchange, and discussion within the group, between groups, and with teachers; the demonstration of knowledge taken on board by the student, theoretical speculation from practice and, finally, the validation of competencies achieved as the course progresses (Figure 6).

EPISTEMIC SUITABILITY

From the indicators addressed during the study, this was the only one evaluated beyond the students, since it determines that the ownership of the contents should be reviewed by academic and expert peers. To this end, the end of each workshop was accompanied by a jury to whom the students presented their findings, followed by a question and answer session. No errors or epistemological inconsistencies were found in the concepts or contents taught and handled by the participants, on the contrary, thanks to these interventions it was demonstrated that the studied statements were reaffirmed by the students, who found conceptual interrelationships and an appropriation of the concepts, being able to generate demonstrations and explanations of these in their own words. This shows the ability to build arguments, solve problems, and suggest connections between knowledge.

COGNITIVE SUITABILITY

When designing the workshops, the competencies acquired in the preliminary curricular units were reviewed and considered, so the level of difficulty handled was appropriate for a course that aimed to generate the appropriate theoretical framework for understanding the principles of bioclimatic architecture. In this way, as a complement, advisory sessions were included to expand upon and reinforce knowledge, where the students were able to clarify doubts and dialog in depth with the teacher on aspects that they had researched following the flipped classroom model. In addition, diverse modes of assessment were proposed that aimed to activate different relevant cognitive and metacognitive processes such as generalization, connections, and conjectures, among others.

To achieve cognitive suitability, it became necessary to monitor the students' performance individually throughout each workshop, because, at first, the changes from the traditional model to the flipped classroom approach generated some resistance. This was manifested in the individual interviews, although in the didactic suitability survey, an average of 4.61 was reached. At this particular point, it was found that about 50% expressed feeling a degree of disorientation or confusion in terms of understanding the statements of the first workshop.

INTERACTIONAL SUITABILITY

The way the teacher conducted the exercise was measured, as were the presentation of the topic and the exercises, the interaction between the teacher and the student, and the spaces offered for dialog. Although a systematic observation of the students' cognitive processes was used in this phase and the dialog and communication between and with the students were observed, the instruments applied highlighted that the levels of interaction could be improved for these.

In the survey results in items 13 and 14 (Table 1) it can be seen that, although more than 60% said they completely agreed with the communication, dialog, and interaction with the teacher, the remaining 40% only agreed or had a neutral opinion, which shows

Table 1. Didactic suitability survey results. Source: Preparation by the authors

	ITEM OF DIDACTIC SUITABILITY	MEAN	STANDARD DEVIATION
1	I clearly understood the ideas and objectives of the exercises from the beginning	4.61	0.61
2	I clearly and precisely understood the relationship between the objectives of the workshops and the subject	4.61	0.47
3	I consider that it improved my ability to analyze and interpret the architectural solutions projected from the climate	4.73	0.44
4	I can recognize values and technological solutions in architectural references that allow me to take advantage of or protect the building from sunlight	4.60	0.48
5	I think that the course enriched my training as an architect	4.86	0.33
6	I consider that the workshops expanded my understanding of architectural actions	4.60	0.37
7	I consider that the exercise improved my appreciation of tropical architecture	4.70	0.45
8	I consider that the workshop provided me with knowledge and processes to project bioclimatic design considerations	4.73	0.37
9	I remained motivated throughout the preparation of the exercises	4.82	0.38
10	The subject allowed me to understand the importance of researching and exploring with an open vision and critical thinking	4.81	0.39
11	I consider that with the workshops I exercised my ability to infer conclusions from premises and evidence that were presented to me in the process	4.60	0.61
12	I consider that the subject led me to reflect and generate new ideas and concepts to find design solutions	4.46	0.61
13	I believe that there was a relevant, effective, and timely dialog with the teacher	4.53	0.61
14	The communication with the teacher throughout the subject was clear and assertive	4.33	0.69
15	The approach of the exercise, the instructions, and the didactic material were sufficient to understand the objectives and scope of the exercise	4.62	0.48
16	I think that the course allowed me to develop my critical thinking	4.60	0.61
17	I consider that throughout the subject I improved my abilities and aptitudes to carry out research regarding collecting information, processing it, and generating conclusions from them	4.66	0.47
18	I think that this course improved my understanding of architecture	4.73	0.44
19	I consider that the course was planned with optimal timing to fulfill its objectives	4.40	0.48
20	I believe that the necessary resources were available at a technical and didactic level to achieve the objectives	4.33	0.86
21	The platforms and means used were the most suitable	4.40	0.48
22	I believe that what I have learned can be used in my work as an architect	4.93	0.24

that the students perceived that they were not fully integrated into the educational process.

MEDIATIONAL SUITABILITY

The use of technologies and support material was evaluated, as well as all aspects related to the environment where the teaching-learning process took place. Given that the approach adopted during this experience was framed under distance learning, it is evident that the use of communication and information technologies became more relevant, which, in this case, were evaluated from the experience perceived by the students through the aforementioned questionnaire. A positive assessment of this instrument was obtained from all the students. However, at a technical level, 14% of the sample expressed neutrality in the statement that the strategies provided had been sufficient, a figure that was observed in the items related to communication with the teacher and the means used, as can be seen in Table 1 in items 19, 20, and 21. From this, it can be inferred that, for the preparation of the workshops, it is necessary to evaluate the items, times, and didactic material provided to the students.

AFFECTIVE SUITABILITY

For this point, the students' interest in the tasks arranged was evaluated. Based on the evidence from the surveys, the assessment was again indisputably positive. This section specifically highlights that, at first, the items that assessed student motivation were estimated with the highest grade and remained constant throughout the exercise, an aspect that was confirmed by the high participation and willingness of the students in the advisory sessions and the interviews conducted individually.

ECOLOGICAL SUITABILITY

Ecological suitability refers to the relationships of the contents taught with the guidelines, objectives, strategies, and contents of the structures that form the context of the curricular unit. In this case, this section saw the best grades from the surveyed students, achieving unanimity in the statements that referred to the contribution of the exercises in their training as architects, the stimulation of critical thinking, the development of research competencies, and the integration of knowledge within the curriculum.

SUMMARY OF DIDACTIC SUITABILITY

The levels of internalization and competencies experienced, according to the teaching-learning processes and from the dimensions of didactic suitability, evidence an acceptance of the flipped classroom strategies in the Architecture and Bioclimatic Urbanism course. In the affective, ecological, epistemic, and cognitive suitability, a strengthening of learning is seen as the cognitive inference processes encompassing implication, reflection, and reasoning operations. However, the mediational and interactional dimensions provide average indices of competition, since distance learning does not favor such interaction. This, although predictable, highlights the didactic potential of the flipped classroom to consolidate achievement indicators in the cognitive, procedural, and, attitudinal aspects, although it is only a small sample of how this modality has an impact on the student's experience at an emotional level. It should be said that, despite the multiple means and strategies applied, the interactional levels were lower.

Similarly, these results show that, in the mediational dimension of the didactic experience, the assessment of students was lower, a fact that can be attributed to the nature of instructional and distance learning means, whose rigidity in planning can be understood as a distancing in the teacher/student relationship.

CONCLUSION

The implementation of these workshops in the Architecture and Bioclimatic Urbanism course shows that inductive learning from practical experience generates an immersion in the knowledge that the student can use as a basis for their project design. This does not mean that the student is a mere receiver, but, on the contrary, behaves as the main agent of the learning process, generating the bases of their knowledge through experience, encouraging their creativity, and stimulating the search. This is in line with the forms of knowledge of Latin American cultures and with architectural learning, as "learning by doing".

Taking the didactic suitability indicators as a starting point to evaluate the teaching, was an enriching strategy. The analysis of the experience around the 6 indicators allowed detecting that the proposed approach of learning by doing had a positive impact on the student, beyond that evidenced in the evaluations. It was possible to interpret through the different items that the process was enjoyable and stimulating for the participants and that the greatest opportunity to improve this methodology was found in the evaluation

planning and the didactic means. In addition, in both cases, it was possible to suggest the construction of a collaborative curriculum and the application of other formats and strategies for the theoretical lessons in future tests, which inevitably form part of the contents described in the program.

Finally, this experience showed that the limitations imposed by the pandemic and distance learning resulted in an opportunity to generate transformations. Although architecture and bioclimatic urbanism learning would have been conventionally structured around the ratification of affirmations, rethinking the academic space for the organization and empowerment of the student gives the conditions to achieve significant learning from the reinterpretation of everyday life. The principles of architecture and bioclimatic urbanism affect our way of experiencing the environment from key concepts such as sensation and thermal quality. That is why embodied thinking through digital tools and teaching advice allows for consolidating and stimulating critical thinking and the fulfillment of competencies.

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