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ÍNDICE

1. **El proceso gráfico como acto narrativo. *The graphic process as a narrative act*.** Grávalos-Lacambra, Ignacio.

2. **El Proyecto de Ejecución Estructural como parte del Proyecto Final de Máster. *Structural execution project as part of the Master's thesis*.** Guardiola-Víllora, Arianna; Mejía-Vallejo, Clara.

3. **La casa de los animales: seminario de composición arquitectónica. *The House of Animals: seminar on architectural composition*.** Gómez-García, Alejandro.

4. **Aula invertida, gamificación y multimedia en Construcción con el uso de redes sociales. *Flipped classroom, gamification and multimedia in Construction by using social networks*.** Serrano-Jiménez, Antonio; Esquivias, Paula M.; Fuentes-García, Raquel; Valverde-Palacios, Ignacio.

5. **Profesional en lo académico, académico en lo profesional: el concurso como taller. *Professionally academic, academically professional: competition as a workshop*.** Álvarez-Agea, Alberto.

6. **Adecuación de un A(t)BP al ejercicio profesional de la arquitectura. *Adaptation of a PB(t)L to the professional practice of architecture*.** Bertol-Gros, Ana; Álvarez-Atarés, Francisco Javier; Gómez Navarro, Belén.

7. **Visualización & Representación: Diseño Gráfico y Producción Industrial. *Visualization & Representation: Graphic Design and Industrial Production*.** Estepa Rubio, Antonio.

8. **Más allá del estado estable: diseño discursivo como práctica reflexiva asistida por IA. *Beyond the Steady State: Discursive Design as Reflective Practice Assisted by AI*.** Lobato-Valdespino, Juan Carlos; Flores Romero, Jorge Humberto.

9. **Geometría y memoria: las fuentes monumento de Aldo Rossi. *Geometry and memory: monument fountains by Aldo Rossi*.** Vílchez-Lara, María del Carmen.

10. **La experiencia de un taller "learning by building" en el diseño de un balcón de madera. *The experience of a "learning by building" workshop in the design of a wooden balcony*.** Serrano-Lanzarote, Begoña; Romero-Clausell, Joan; Rubio-Garrido, Alberto; Villanova-Civera, Isaac.

11. **Diseño de escenarios de aprendizaje universitarios para aprender haciendo. *University learning scenarios design for learning-by-doing*.** Prado-Acebo, Cristina.

12. **Cartografiando el acoso sexual: dos TFG sobre mujeres y espacio público en India*. Mapping Sexual Harassment: Two Undergraduate Theses on Women and Public Space in India*.** Cano-Ciborro, Víctor.

13. **Comparar, dialogar, proyectar*. Comparing, discussing, designing*.** Mària-Serrano, Magda; Musquera-Felip, Sílvia.

14. **Talleres preuniversitarios: itinerarios, bitácoras y mapas con niñxs*. Pre-university workshops: Itineraries, Sketchbooks, Maps with Kids*.** De Jorge-Huertas, Virginia; Ajuriaguerra-Escudero, Miguel Ángel.

15. **Dibujar y cartografiar: un marco teórico para arquitectura y paisajismo*. Drawing and mapping: a theoretical framework for architecture and landscape*.** De Jorge-Huertas, Virginia; Rodriguez-Aguilera, Ana Isabel.

16. **La especialización en el modelo formativo de las Escuelas de Arquitectura en España*. Specialization in the formative model of the Schools of Architecture in Spain*.** López-Sánchez, Marina; Vicente-Gilabert, Cristina.

17. **Regeneración paisajística de la Ría de Pontevedra: ApS para la renaturalización de Lourizán. *Ria de Pontevedra landscape regeneration: Service-Learning to rewild Lourizán*.** Rodríguez-Álvarez, Jorge; Vázquez-Díaz, Sonia.

18. **Manos a la obra: de la historia de la construcción a la ejecución de una bóveda tabicada*. Hands on: from the history of construction to commissioning of a timbervault*.** Gómez-Navarro, Belén; Elía-García, Santiago; Llorente-Vielba, Óscar.

19. **Artefactos: del co-diseño a la co-fabricación como acercamiento a la comunidad*. Artifacts: from co-design to co-manufacturing as approach to the community*.** Alberola-Peiró, Mónica; Casals-Pañella, Joan; Fernández-Rodríguez, Aurora.

20. **Análisis y comunicación: recursos docentes para acercar la profesión a la sociedad*. Analysis and communication: teaching resources to bring the profession closer to society*.** Díez Martínez, Daniel; Esteban Maluenda, Ana; Gil Donoso, Eva.

21. **Desafío constructivo: una vivienda eficiente y sostenible. *Building challenge: efficient and sustainable housing*.** Ros-Martín, Irene; Parra-Albarracín, Enrique.

22. **¿Mantiene usted sus ojos abiertos? La fotografía como herramienta transversal de aprendizaje. *Do you keep your eyes open? Photography as a transversal learning tool*.** González-Jiménez, Beatriz S.; Núñez-Bravo, Paula; Escudero-López, Elena.

23. **El COIL como método de aprendizaje: estudio de la iluminación natural en la arquitectura. *The COIL as a learning method: Study of natural lighting in architecture*.** Pérez González, Marlix T.

24. **Viaje virtual a Amsterdam a través del dibujo. *Virtual trip to Amsterdam through drawing*.** Moliner-Nuño, Sandra; de-Gispert-Hernandez, Jordi; Bosch-Folch, Guillem.

25. **Los juegos de Escape Room como herramienta docente en Urbanismo: una propuesta didáctica. *Breakout Games as a teaching tool in Urban Planning: a didactic strategy*.** Bernabeu-Bautista, Álvaro; Nolasco-Cirugeda, Almudena.

26. **Happenings Urbanos: acciones espaciales efímeras, reflexivas y participativas. *Urban Happenings: Ephemeral, Reflective and Participatory Spatial Actions*.** Blancafort, Jaume; Reus, Patricia.

27. **Sensibilizando la arquitectura: una propuesta de ApS en el Centro Histórico de Quito. *Sensitizing architecture: An ApS proposal in the Historic Center of Quito*.** González-Ortiz, Juan Carlosa; Ríos-Mantilla, Renato Sebastiána; Monard-Arciniégas, Alexka Shayarina.

28. **Regeneración urbana en el grado de arquitectura: experiencia de taller, San Cristóbal, Madrid. *Urban regeneration in the architecture degree: Workshop experience in San Cristóbal, Madrid*.** Ajuriaguerra Escudero, Miguel Angel.

29. **De las ideas a las cosas, de las cosas a las ideas: la arquitectura como transformación. *From ideas to things, from things to ideas: Architecture as transformation*.** González-Cruz, Alejandro Jesús; del Blanco-García, Federico Luis.

30. **A propósito del documental "Arquitectura Emocional 1959": elaborar un artículo de crítica. *Regarding the documentary "Emotional Architecture": Preparing a critical article*.** Moreno Moreno, María Pura.

31. **El modelo de Proyecto Basado en la investigación para el aprendizaje de la Arquitectura. *The Design-Research Model for Learning Architecture*.** Blanco Herrero, Arturo; Ioannou, Christina.

32. **La colección Elementos: un archivo operativo para el aprendizaje arquitectónico. *The Elements collection: an operational archive for architecture learning*.** Fernández-Elorza, Héctor Daniel; García-Fern, Carlos; Cruz-García, Oscar; Aparicio-Guisado, Jesús María.

33. **Red de roles: role-play para el aprendizaje sobre la producción social del hábitat. *Roles Network: role-play learning on the social production of habitat*.** Martín Blas, Sergio; Martín Domínguez, Guiomar.

34. **Proyecto de Aprendizaje-Servicio en Diseño y Viabilidad de Proyectos Arquitectónicos. *Service-Learning in Architectural Projects Design and Feasibility*.** García-Asenjo Llana, Davida; Vicente-Sandoval González, Ignacio; Echarte Ramos, Jose María; Hernández Correa, José Ramón.

35. **La muerte del héroe: la creación de una narrativa profesional inclusiva y cooperativa. *The hero's death: The creation of an inclusive and cooperative professional narrative*.** García-Asenjo Llana, David; Vicente-Sandoval González, Ignacio; Echarte Ramos, Jose María.

36. **Modelado arquitectónico: construyendo geometría. *Architectural modeling: constructing geometry*.** Crespo-Cabillo, Isabel; Àvila-Casademont, Genís.

37. **Propiocepciones del binomio formación-profesión en escuelas de arquitectura iberoamericanas. *Self awareness around the education-profession binomio in iberoamerican architecture schools*.** Fuentealba-Quilodrán, Jessica; Barrientos-Díaz, Macarena.

38. **Experiencing service learning in design-based partnerships through collective practice. *Aprendizaje-servicio en proyectos comunitarios a través de la práctica colectiva*.** Martinez-Almoyna Gual, Carles.

39. **Aprendizaje basado en proyectos: estudio de casos reales en la asignatura de Geometría. *Project-based learning: study of real cases in the subject of Geometry*.** Quintilla-Castán, Marta.

40. **El sílabo como dispositivo de [inter]mediación pedagógica. *Syllabus as pedagogical [inter]mediation device*.** Casino-Rubio, David; Pizarro-Juanas, María José; Rueda-Jiménez, Óscar; Robles-Pedraza, David.

41. **Didáctica en arquitectura: el dato empírico ambiental como andamiaje de la creatividad. *Didactics in architecture: the empirical environmental data as a support for creativity*.** Lecuona, Juan.

42. **Navegar la posmodernidad arquitectónica española desde una perspectiva de género. *Surfing the Spanish architectural postmodernity from a gender perspective*.** Díaz-García, Asunción; Parra-Martínez, José; Gilsanz-Díaz, Ana; Gutiérrez-Mozo, M. Elia.

43. **Encontrar: proyectar con materiales y objetos comunes como herramienta docente. *Found: designing with common materials and objects as a teaching tool*.** Casino-Rubio, David; Pizarro-Juanas, María José; Rueda-Jiménez, Óscar; Ruiz-Bulnes, Pilar.

44. **Modelo pedagógico para el primer curso: competencias para la resolución de problemas abiertos. *Pedagogical model for the first year of undergraduate studies: development of open problem solving skills*.** Gaspar, Pedro; Spencer, Jorge; Arenga, Nuno; Leite, João.

45. **Dispositivos versus Simuladores en la iniciación al proyecto arquitectónico. *Devices versus Simulators in the initiation to the architectural project*.** Lee-Camacho, Jose Ignacio.

46. **Implementación de metodologías de Design Thinking en el Taller de Arquitectura. *Implementation of Design Thinking methodologies in the Architectural Design Lab*.** Sádaba, Juan; Collantes, Ezekiel.
.
47. **Jano Bifronte: el poder de la contradicción. *Jano Bifronte: the power of contradiction*.** García-Sánchez, José Francisco.

48. **Vitruvio nos mira desde lejos: observar y representar en confinamiento. *Vitruvio Looks at us from Afar: Observing and Representing in Confinement*.** Quintanilla Chala, José Antonio; Razeto Cáceres, Valeria.

49. **Muro Virtual como herramienta de aprendizaje para la enseñanza colaborativa de un taller de arquitectura. *Virtual Wall as a learning tool for collaborative teaching in an architecture workshop*.** Galleguillos-Negroni, Valentina; Mazzarini-Watts, Piero; Harriet, De Santiago, Beatriz; Aguilera-Alegría, Paula.

50. **Ritmos Espaciales: aprender jugando. *Ritmos Espaciales: Learn by playing*.** Pérez-De la Cruz, Elisa; Ortega-Torres, Patricio; Galdames-Riquelme, Alejandra Silva- Inostroza, Valeria.

51. **Experiencias metodológicas para el análisis del proyecto de arquitectura *Methodological experiences for architectural project analysis*.** Aguirre-Bermeo, Fernanda; Vanegas-Peña, Santiago.

52. **Fabricando paisajes: el estudio del arquetipo como forma de relación con el territorio. *Making landscapes: the study of the archetype as a way of relating to the territorys*.** Cortés-Sánchez, Luis Miguel.

53. **Resonar en el paisaje: formas de reciprocidad natural-artificial desde la arquitectura. *Landscape resonance: natural-artificial reciprocities learnt from architecture*.** Carrasco-Hortal, Jose.

54. **Investigación del impacto del Solar Decathlon en estudiantes: análisis de una encuesta. *Researching the impact of the Solar Decathlon on students: a survey analysis*.** Amaral, Richard; Arranz, Beatriz; Vega, Sergio.

55. **Urban Co-Mapping: exploring a collective transversal learning model. *Urban Co-mapping: modelo de aprendizaje transversal colectivo*.** Toldi, Aubrey; Seve, Bruno.

56. **Docencia elástica y activa para una mirada crítica hacia el territorio y la ciudad del siglo XXI. *Elastic and active teaching for a critical approach to the territory and the city oaf the 21st century*.** Otamendi-Irizar, Irati; Aseguinolaza-Braga, Izaskun.

57. **Adoptar un rincón: taller de mapeo y acción urbana para estudiantes de arte. *Adopting a corner: mapping and urban action workshop for art students*.** Rivas-Herencia, Eugenio; González-Vera, Víctor Miguel.

58. **Aprendizaje-Servicio: comenzar a proyectar desde el compromiso social.** ***Service-Learning: Start designing from social engagement*****.** Amoroso, Serafina; Martínez-Gutiérrez, Raquel; Pérez-Tembleque, Laura.

59. **Emergencia habitacional: interrelaciones entre servicio público y academia en Chile.** ***Housing emergency: interrelations between public service and academia in Chile*****.** Fuentealba-Quilodrán, Jessica; Schmidt-Gomez, Denisse.

60. **Optimización energética: acercando la práctica profesional a distintos niveles educativos.** ***Energy optimization: bringing professional practice closer to different educational levels*****.** López-Lovillo, Remedios María; Aguilar-Carrasco, María Teresa; Díaz-Borrego, Julia; Romero-Gómez, María Isabel.

61. **Aprendizaje transversal en hormigón.** ***Transversal learning in concrete*****.** Ramos-Abengózar, José Antonio; Moreno-Hernández, Álvaro; Santolaria-Castellanos, Ana Isabel; Sanz-Arauz, David.

62. **Un viaje como vehículo de conocimiento del Patrimonio Cultural.** ***A journey as a vehicle of knowledge about Cultural Heritage*****.** Bailliet, Elisa.

63. **La saga del Huerto Vertical de Tomé: ejecución de proyectos académicos como investigación.** ***The saga of the Vertical Orchard of Tome: execution of academic projects as research*****.** Araneda-Gutiérrez, Claudio; Burdiles-Allende, Roberto.

64. **Lo uno, y también lo otro: contenedor preciso, programa alterno.** ***The one, and also the other: precise container, alternate program*****.** Castillo-Fuentealba, Carlos; Gatica-Gómez, Gabriel.

65. **Elogio a la deriva: relatos del paisaje como experiencias de aprendizajes.** ***In praise of drift: landscape narratives as learning experiences*****.** Barrale, Julián; Seve, Bruno.

66. **De la academia al barrio: profesionales para las oficinas de cercanía.** ***From the academy to the neighbourhood: professionals for one-stop-shops*****.** Urrutia del Campo, Nagore; Grijalba Aseguinolaza, Olatz.

67. **Habitar el campo, cultivar la casa: aprendizaje- servicio en el patrimonio agrícola.** ***Inhabiting the field, cultivating the house: service-learning in agricultural heritage*****.** Escudero López, Elena; Garrido López, Fermina; Urda Peña, Lucila

68. **Mare Nostrum: una investigación dibujada.** ***Nostrum Mare: a Drawn Research*****.** Sánchez-Llorens, Mara; de Fontcuberta-Rueda, Luis; de Coca-Leicher, José.

69. **El Taller Invitado: un espacio docente para vincular profesión y formación.** ***"El Taller Invitado": a teaching space to link profession and education*****.** Barrientos-Díaz, Macarena Paz; Solís-Figueroa, Raúl Alejandro.

70. **Ensayos y tutoriales en los talleres de Urbanismo+Proyectos de segundo curso. *Rehearsals and tutorials in the second year Architecture+Urban design Studios*.** Tiñena Guiarnet, Ferran; Solans Ibáñez, Indibil; Buscemi, Agata; Lorenzo Almeida, Daniel.

71. **Taller Amereida: encuentros entre Arquitectura, Arte y Poesía. *Taller Amereida: encounters between Architecture, Art and Poetry*.** Baquero-Masats, Paloma; Serrano-García, Juan Antonio.

72. **Crealab: punto de encuentro entre los estudiantes de arquitectura y secundaria. *Crealab: meeting point between architecture and high-school students*.** Cobeta-Gutiérrez, Íñigo; Sánchez-Carrasco, Laura; Toribio-Marín, Carmen.

73. **Laboratorios de innovación urbana: hacía nuevos aprendizajes entre academia y profesión. *Urban innovation labs: towards new learning experiences between academia and profession*.** Fontana, María Pia; Mayorga, Miguel; Genís-Vinyals, Mariona; Planelles-Salvans, Jordi.

74. **Réplicas interiores: un atlas doméstico. *Interior replicas: a domestic atlas*.** Pérez-García, Diego; González-Pecchi, Paula.

75. **Arquitectura efímera desde la docencia del proyecto: la construcción del proyecto en la ciudad. *Ephemeral architecture from teaching of the project: construction of the project in the city*.** Ventura-Blanch, Ferran; Pérez del Pulgar Mancebo, Fernando; Álvarez Gil, Antonio.

76. **Start-up Education for Architects: Fostering Green Innovative Solutions. *Educación Start-up para arquitectos: fomentar soluciones ecológicas innovadoras*.** Farinea, Chiara; Demeur, Fiona.

77. **10 años, 10 concursos, 10 talleres: un camino de desarrollo acádemico. 10 years, *10 contests, 10 design studios: a trail in academic development*.** Prado-Lamas, Tomás.

78. **El Proyecto Experiencial: la titulación de arquitectos a través de proyectos no convencionales. *"El Proyecto Experiencial": non-conventional projects for architecture students in the final studio*.** Solís-Figueroa, Raúl Alejandro.

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80. **Propuesta de mejora de los indicadores de calidad de la enseñanza de la arquitectura. *Proposal to improve the quality indicators of architecture teaching*.** Santalla-Blanco, Luis Manuel.

81. **Aprender de la experiencia: el conocimiento previo en la formación inicial del arquitecto.** ***Learning from experience: The role of prior knowledge in the initial training of architects*****.** Arias-Jiménez, Nelson; Moraga-Herrera, Nicolás; Ortiz-Salgado, Rodrigo; Ascui Fernández, Hernán.

82. **Iluminación natural: diseño eficiente en espacios arquitectónicos.** ***Daylight: efficient design in architectural spaces*****.** Roldán-Rojas, Jeannette; Cortés-San Román, Natalia.

83. **Fundamentación en arquitectura: el estado de la cuestión.** ***Architecture basic course: state of knowledg*****e**. Estrada-Gil, Ana María; López Chalarca, Diego; Suárez-Velásquez, Ana Mercedes; Uribe-Lemarie, Natalia.

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Start-up Education for Architects: Fostering Green Innovative Solutions

Educación Start-up para arquitectos: fomentar soluciones ecológicas innovadoras

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Abstract

The needs and challenges of today's planet continue to evolve and change, as does the role of the architect. Historically, architecture was discipline bound, and today still has a very strict curriculum. However, to address different challenges, architects must work with other disciplines and learn from them. This must begin at the level of higher education. Urban Shift, is an experimental cross border programme designed to bring students from different disciplines -architecture, media, business- and different educational levels -university and vocational education training- to work together in developing start-up solutions. Through methods like learning by doing, student entrepreneurs are able to form transdisciplinary groups, identify a problem, ideate a solution, prototype and pitch. As a result of the programme, seven start-ups were developed demonstrating the need for architectural education to change and foster innovation.

***Keywords:** start-up education, learning by doing, transdisciplinary groups, cross-border education, green innovation*

***Thematic areas:** technology, active methodologies, experimental pedagogy.*

Resumen

Las necesidades y retos del planeta actual siguen evolucionando y cambiando, al igual que el papel del arquitecto. Históricamente, la arquitectura estaba ligada a una disciplina, y hoy en día sigue teniendo un plan de estudios muy estricto. Para abordar los distintos retos, los arquitectos deben trabajar con otras disciplinas y aprender de ellas. Esto debe empezar en la enseñanza superior. Urban Shift, es un programa experimental transnacional diseñado para reunir a estudiantes de distintas disciplinas -arquitectura, medios de comunicación, empresa- y distintos niveles educativos -universidad y formación profesional- para que trabajen juntos en el desarrollo de soluciones de nueva creación. Mediante métodos como el aprendizaje práctico, los estudiantes pueden formar grupos transdisciplinares, identificar un problema, idear una solución, crear prototipos y presentarlos. Como resultado del programa, se desarrollaron siete start-ups que demuestran la necesidad de que la enseñanza de la arquitectura cambie y fomente la innovación.

***Palabras clave:** educación start-up, aprendizaje práctico, grupos transdisciplinares, educación transfronteriza, innovación ecológica*

***Bloques temáticos:** tecnología, metodologías activas, pedagogía experimental.*

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Titulación: Master

Nivel/curso dentro de la titulación: seminario de máster

Denominación oficial asignatura, experiencia docente, acción: seminario de 6 meses

Departamento/s o área/s de conocimiento: Arquitectura

Número profesorado: 3 en la parte de arquitectura

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Introduction

Traditionally, architecture education has been structured around a well-defined curriculum aimed at equipping students with the necessary technical and design skills to qualify as architects. Architecture courses ensure that graduates are prepared to create functional, aesthetically pleasing, and structurally sound buildings. However, the role of the architect has been undergoing significant transformation due to interconnected global challenges, most notably rapid and unsustainable urbanisation and climate change. As cities grow at an unprecedented pace and environmental concerns become more pressing, architects are required to address such complex challenges. This has led to a shift in the expectations placed on architecture education to incorporate sustainability principles into the curriculum (Boarin and Martinez-Molina, 2022). Architecture is no longer just architecture. Architects are becoming integral players in shaping the future of our cities and communities, adapting to the challenges of our time and driving positive change. Beyond the necessary professional knowledge, architects generally have strong skills in problem-solving, creative thinking and project management that are highly valued in various industries. Architects find themselves exploring diverse career options for instance in urban planning, design, policy-making or academia. Moreover, an entrepreneurial mindset, starting their own design business, is common within the architecture community. Thus, it is crucial that architecture education equips future architects to offer solutions to complex challenges, adapt to the expanding professional horizon, and excel as collaborative team members who value transdisciplinary approaches.

This paper focuses on the Urban Shift (2022) project, an educational initiative co-funded by the Erasmus+ Programme of the European Union. The project unites higher education institutes, a vocational education training entity, and companies from five EU countries in the fields of architecture, media, and business. Its main goal is to provide innovative transdisciplinary start-up education that empowers students to initiate start-ups, devising holistic and hands-on solutions for fighting climate change in urban areas aligned with the objectives of the European Green Deal. Within the first phase of the program, 40 students were challenged to address two fundamental topics: (1) Urban Heat Islands, delving into the intricate balance between cooling and heating within urban environments and (2) Food Waste/Circularity, with the aim of advancing industry sustainability while mitigating the environmental and climate impacts. Through a collaborative learning-by-doing approach, students - organised into groups comprising expertise in architecture, media, and business - had the opportunity to translate their ideas into sustainable business solutions.

A Need for Transdisciplinary Education

According to Max-Neef (2005), transdisciplinarity means seeing the world in a holistic way. Scholars agree that a transdisciplinary approach is essential for addressing the complex global challenges we face in the 21st century. Bernstein (2015) characterises transdisciplinarity as being focused on *"wicked problems"*. It can be argued that the outcome of a transdisciplinary research is a unique knowledge based on merging diverse disciplines (Derry and Fischer, 2005). Educational institutions play a central role in training future change-makers capable of thinking beyond disciplinary boundaries. Yet, widespread traditional education requires students to specialise in a particular field and does not give them the freedom to look beyond the chosen subject (Farinea and Demeur, 2022). To achieve a successful transdisciplinary approach in education, creating a trusting environment where each element respects and recognizes the knowledge of others is fundamental (Farinea et al., 2021). As stated by Derry and Fisher (2015),

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in today's world of living and working, transdisciplinary education is essential. Individuals are confronted with *"uncertainty, change, and intelligence that is distributed across cultures, disciplines, and tools"*. Consequently, *"graduate programs should foster transdisciplinary competencies and mindsets that prepare students for having meaningful and productive lives in such a world."*

As noted by Karslı and Özker (2014), architecture education encompasses practical techniques as well as conceptual notions like imagination, intuition, flexibility, and creativity. Architecture educators have already realised that change is very much needed the way the discipline is taught at universities (Wang, 2010, as cited in Nikezic and Markovic, 2013). Traditional architecture education is unable to prepare students to adapt to the rapid changes of the modern world (Nikezic and Markovic, 2013). As conventional training methods are challenged, an increasing number of schools turn to alternative approaches like learning-by-doing. By Bruce and Bloch (2012), the definition of learning-by-doing is a *"process whereby people make sense of their (...) experiences in which they actively engage in making things and exploring the world"*. Rae and Carswell (2000) suggest that by using the learning-by-doing approach, students can develop entrepreneurial abilities and expertise (Chang et al., 2014). Learning-by-doing is not a recent concept in architecture as it existed prior to the establishment of university-based architecture education and it was historically used to acquire professional skills (Nikezic and Markovic, 2013). According to Coleman (2010), university-based architecture education intensified the division between theory and practice. In architecture education, maintaining a balance between theory and practice while fostering an experiential learning environment is crucial. Studio-based learning can offer a platform for experimentation, employing the learning-by-doing approach, and nurturing creativity. As noted by Mayuk and Coşgun (2020), studios in architectural education function as dynamic learning environments, departing from the traditional classroom approach.

In a 2016 interview with Dezeen, Odile Decq argued that architecture goes beyond mere construction: it is dealing with complex challenges. In addition, she highlighted the significance of transdisciplinary architectural education. The Confluence Institute, established by Decq in 2014, states in its manifesto that *"architecture is at the encounter of disciplines"* (Confluence Institute, n.d). Numerous scholars and professionals have expressed the necessity for transdisciplinarity in architecture, design, and urban planning education. Lawrence and Després (2004) argue that since the disciplines of architecture and urban planning are inherently multidisciplinary, they have potential to establish dialogue with diverse fields including natural, social and human sciences. Such dialogue could enhance and strengthen the process of identifying and addressing intricate urban challenges (Després et al., 2010).

Even though the role of the architect is undergoing major changes, most architecture courses still follow the traditional curricula. According to Després et al. (2010), in the context of the USA and Canada, architecture students do not acquire sufficient training to interact with researchers from social sciences and interpret scientific results. A comparable scenario applies to the field of design and design education. As design work has shifted towards interaction, service, and experience design which often involves complex social issues, designers have to 'act' as scientists even though they are lacking sufficient training (Norman, 2010). *"Design schools do not train students about [...] the interlocking complexities of human and social behaviour, about the behavioural sciences, technology, and business"* (Norman, 2010 as cited in Camacho and Alexandre, 2019). Additionally, practical real-life projects are typically missing in design education. Camacho and Alexandre (2019) states that design education *"happens in hypothetical contexts indifferent to reality or the surrounding context, disregarding articulation between academy and industry".*

In addition to collaborating with sciences, a strong business sense is vital in architecture. The American Institute of Architects' publication, "The Architect's Handbook of Professional Practice," asserts that *"twenty-first-century business realities require that entrepreneurial architects and their staff develop skills in business management"* (Klein, 2014, as cited in Vosloo et al., 2018). Moreover, Richardson (2011) argues that *"architecture is entrepreneurship"* highlighting that the definition of entrepreneurship can easily be applied to architecture. While entrepreneurship is defined as *"a process of creating value by bringing together a unique combination of resources to exploit an opportunity"*, architects are *"skilled in leveraging opportunities by bringing together a diverse combination of resources to create value"* (Richardson, 2011). Continuing his argument, Richardson (2011) argues that despite architecture inherently embodies entrepreneurial elements, educational programs often neglect comprehensive entrepreneurial training.

The Urban Shift Methodology

Based on the need to adapt architectural education and foster transdisciplinary education, the project Urban Shift was developed following the successful Erasmus+ project BUILD Solutions (2018). BUILD Solutions focused on developing 5 transdisciplinary nature-based solution start-ups with business, biology and architectural students. From the learnings of BUILD Solutions, the Urban Shift methodology was developed as a continuation of the latter, but adapted to meet the needs of the project. Urban Shift brings together architecture, business, media students and professionals pursuing vocational education training to address urban challenges in line with the European Green Deal.

Urban Shift is a three year Erasmus+ Project with educational courses running in the first and second year of the project and therefore, resulting in two batches of students addressing different urban challenges. As part of the project, a Living Curriculum and Living Lab Programme was set up in 2023, addressing Urban Heat Islands and Food Waste/Circularity. The Living Curriculum is a curriculum that can be adapted and updated between batches, taking the learnings from the first batch and applying it to the second, while Living Labs refers to the programme the students are enrolled in. Through a learning-by-doing approach, an entrepreneurial journey (Fig.1) was developed following the curriculum that allowed the students to interact, support and develop innovative solutions.

Fig. 1 Entrepreneurial Journey. Urban Shift (2023)

To utilise the network and to capitalise on the expertise from various disciplines, the cross-border programme, combines both online and presential classes, workshops and events. To facilitate the cross-boarder and transdisciplinary approach to teaching and learning, the students and trainers (faculty) participated in online Bridging Courses before the official kick-off. Through tools such as Miro and Mentimeter, and activities like Speed Dating, the students were encouraged to engage with each other and start to learn more about the challenges they would address before meeting in person. Forming a strong team foundation is fundamental to ensuring success in the

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transition from presential to online communication. The group formation was done based on surveys and personality tests, with the students ultimately having the final say when they met in person.

The Living Labs programme has been designed with three major milestones, a presential Kick-off, an online midway pitch and a final presential final pitch. During the Kick-off workshop the students followed a double diamond methodology (Fig.2) to ideate and develop their start-up ideas through Design Thinking and learning-by-doing. Just as fundamental to the success of the teams' development was the integration of a wide variety of team building activities that encouraged students to interact, challenge and learn from each other.

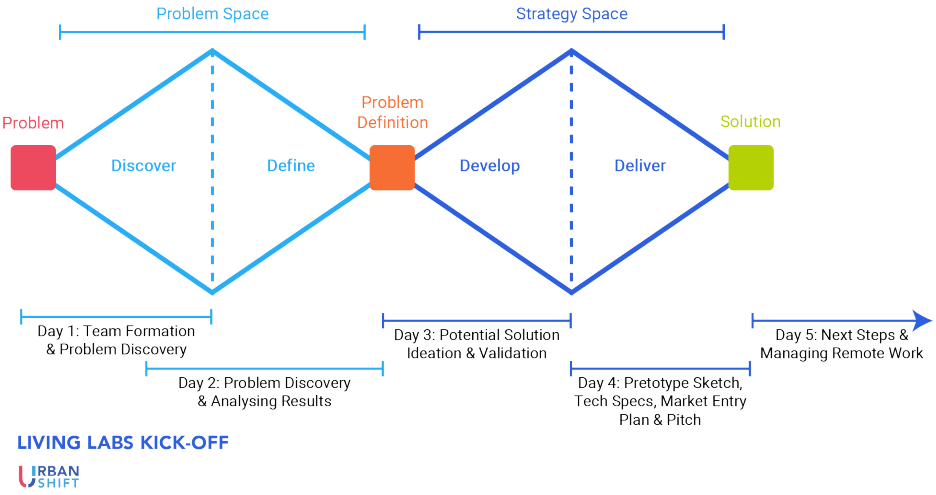

Fig. 2 Double Diamond Methodology. Urban Shift (2023)

The next major milestone for the entrepreneurs was the Midway Pitch and Round Table. Having transitioned from presential to online working, during this event the students were able to pitch their initial ideas and get feedback from industry experts on the development of their start-up. The last milestone is the Final Pitch which took place in person in the form of a workshop. During the closing workshop, students finalised their first prototypes, reflected on the next steps and produced a three minute pitch for industry experts.

The milestones were supported by a series of classes that took place at each higher education institution, specific to the discipline, and online classes focussing on entrepreneurial skills from the business partners. From the architecture and design perspective, students work with digital fabrication to test their ideas and prototype. This includes the development of biomaterials, robotic clay 3d printing and nature-based solutions. In addition, the students received classes focusing on applying for funding through European Union initiatives and the technology readiness level, allowing the students to position their work in the professional world.

Once the Living Labs programme finishes, the students become part of the Green Ambassador network where trainers can continue to support and share opportunities. The 2023 students will also actively participate to support the students participating in the following batch. Additionally, a set of exhibitions will be hosted in each of the higher education cities showcasing and promoting the work of the start-ups. These opportunities allow the students to feel motivated and to continue striving to make their start-up a reality.

Through this programme, the trainers take the role of mentors and supporters, and the students drive their projects based on learning-by-doing through research, prototyping and market validation. This allows the students to develop lifelong skills as they are confronted with different obstacles and stakeholders along the way. The trainers did not dictate or tell the students what to do, rather they guide them and support them through their entrepreneurial journey.

Results

The Living Labs 2023, which took place from January 2023 to June 2023, brought together 40 students from four institutions; the Vienna University of Economics and Business, the Institute for Advanced Architecture of Catalonia (IAAC), Stuttgart Media University, and the Vienna-based Institute for Economic Promotion. The Living Labs 2023's primary goal was to test the Living Curriculum, designed to support transdisciplinary start-up education in line with the European Green Deal. During the programme, students collaborated in international, transdisciplinary groups. By the conclusion of the Living Labs 2023, the students had successfully formed seven start-ups tackling the two urban challenges: (1) Urban Heat Islands, and (2) Food Waste/Circularity. The start-ups delved into the challenges exploring recycling food waste into innovative products, generating savings for consumers, and mitigating the environmental and climate impacts associated with food and urban heat islands. The following section will introduce the seven student start-ups. The introductory texts have been written by the start-ups and reviewed and edited by the authors of this paper.

"*UrbanCork aims to foster sustainable urban transformation through a cutting-edge cork tile that not only boosts the visual appeal of cities but also brings nature back to the urban environment. The modular cork tiles offer a range of benefits, from heat reflection and shock absorption to water permeability, they provide enhanced comfort, improved urban climate while creating spaces where nature can flourish. By using a natural and eco-friendly material, UrbanCork challenges the norm of city infrastructure. Collaborating with experts in material research and fabrication, UrbanCork pushes the boundaries of eco-friendly urban design.*" (UrbanCork, 2023)

Fig. 3 Prototype of UrbanCork. Source: UrbanCork - Urban Shift (2023)

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"Soller is an intuitive solar blind-light that generates green energy while offering shade and soft light for interiors. The product aims to achieve flexibility, transparency, and beauty, while supporting sustainability through green energy generation and energy conservation. The underlying concept of Soller is rooted in established technologies, seamlessly integrating a lighting system and solar cell electronics into a flexible and transparent material. In the evening, the lighting surrounding the blinder will give the interior a soft atmosphere. Once not in use, the product conveniently rolls up with minimal packaging requirements. The blind-light is constructed using organic photovoltaic film, a third-generation solar technology printed on thin foils, resulting in a product thickness of less than 1mm and up to 50% transparency. The energy captured by the blinder is stored in an integrated battery inside the railings." (Soller, 2023)

Fig. 4 Render of Soller. Source: Soller - Urban Shift (2023)

"*Ovolo repurposes waste eggshells into waterproof tiles for buildings. With global egg production predicted to expand, the disposal of eggshells in landfills without recycling is a missed opportunity. Up to 130 eggshells are utilised for each Ovolo tile. The sustainable Ovolo tiles are exceptionally durable and have a resilient texture. They outperform regular tiles, offering crack resistance, lightweight properties, and temperature regulation. Moreover, the tiles can be customised with various finishes, ranging from smooth and polished to rough and dense.*" (Ovolo, 2023)

Fig. 5 Prototype of Ovolo. Source: Ovolo - UrbanShift (2023)

“Planterra aims to revolutionise office spaces. It offers ‘Effortless Greenery Solutions’ that address the challenges of incorporating plants in workplaces. The package of solutions include tailored plant selection for office conditions, hassle-free maintenance, and a smart, sustainable plant infrastructure. The thoughtfully designed plantholder modular frame, crafted from wood and cork, seamlessly incorporates water storage pots. Planterra's innovative approach enhances aesthetics, improves air quality, mitigates noise and promotes well-being in workplaces.” (Planterra, 2023)

Fig. 6 Prototype of Planterra. Source: Planterra - Urban Shift (2023)

“Klimatile offers an innovative, sustainable solution to combat urban heat islands, with a sustainable, passive cooling solution, enhancing the comfort of city life. The cladding system employs evaporative cooling to naturally reduce the interior and surrounding temperatures by 3-10 degrees Celsius. Klimatile combines aesthetics with sustainability, featuring captivating designs on clay surfaces. Klimatile's easy-to-install, locally produced clay tiles outperform competitors due to its passive cooling capabilities. It supports green building goals, saving costs and enhancing comfort. By reducing temperatures, Klimatile contributes to a better urban environment, addressing climate change challenges.” (Klimatile, 2023)

Fig. 7 Prototype of Klimatile. Source: Klimatile - Urban Shift (2023)

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"SustainaBite is dedicated to combat food waste, with a particular emphasis on household food waste, which accounts for over 55% of the total. To address this issue, SustainaBite proposes an app that empowers customers to find discounted food products from nearby retailers. Through the app, customers can access recipes that utilise complementary food items in precise quantities, ensuring minimal wastage. Users can conveniently order and pick up these items. In cases where discounted products are not available, the app provides a diverse selection of recipes, including those crafted by renowned chefs." (SustainaBite, 2023)

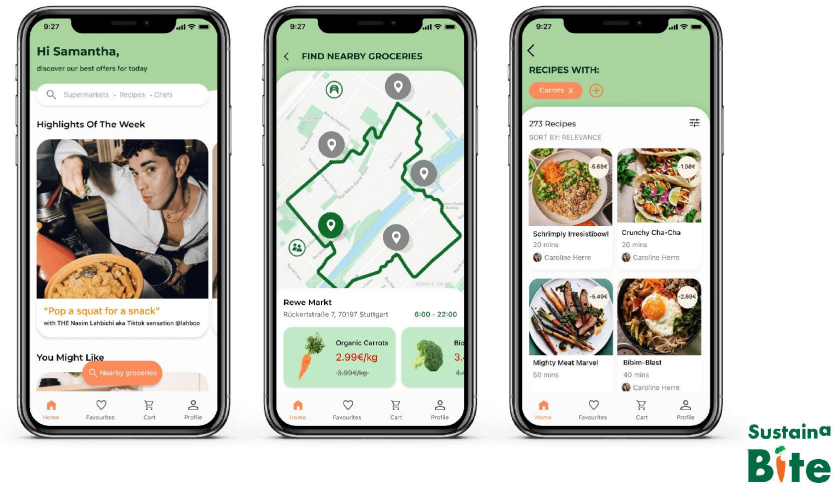

Fig. 8 App design of SustainaBite. Source: SustainaBite - Urban Shift (2023)

"Second Slice proposes to repurpose bread waste into vegan leather through the use of mycelium technology offering an environmentally conscious alternative to conventional leather production, and simultaneously curbing food waste. By harnessing mycelium's transformative potential, Second Slice has pioneered a method that converts discarded bread into a versatile, leather-like material. Through their unique approach, Second Slice envisions a transformative impact on the leather industry." (Second Slice, 2023)

Fig. 9 Prototype of Second Slice. Source: Second Slice Urban Shift (2023)

The results of the start-ups varied in terms of level of development. This was as a result of different factors, such as team dynamics, and levels of motivation. As some of the start-ups developed and evolved their ideas, some students lost motivation as the solution was no longer what they thought it was going to be. Many of the group dynamic challenges are believed to also come from the approach to group formation. Even though some students encountered challenges within their groups, all students believe that this kind of teaching should be incorporated into mainstream architectural or higher education programmes.

One of the highlights of the programme was the Closing Ceremony in Barcelona, hosted by IAAC. The students had a boost of motivation when they saw the prototypes the IAAC students had produced and expressed their inspiration of being in such a creative environment. The Final Pitch was formatted in competition, with each group getting 3 minutes to pitch, followed by a 10 minute interrogation by the jury. The jury consisted of invited business innovation experts as well as faculty from IAAC. The invited jury were thoroughly impressed by the level of development of the start-ups, especially the prototypes they had already created. As a result, some groups were approached by one of the business experts as he was interested in supporting their idea and investing. This was a testament to the success of implementing a transdisciplinary programme within an architectural masters programme.

Discussion

As Living Labs 2023 has concluded, the lessons learned will be taken into consideration in preparation for the 2024 edition. Firstly, it is crucial to establish a positive dynamic within the transdisciplinary student teams. Good team dynamics are not self-evident, as students come from very different educational and cultural backgrounds. While this diversity presents an opportunity for fruitful collaboration, it also makes it difficult to find common ground and work together efficiently. Additionally, keeping all 40 students motivated and focused throughout the semester can be challenging. Since students come from different countries, after the first kick-off week, they return to their home universities and continue working together online. It became apparent that the initial motivation diminished as collaborative work continued in the virtual environment, with some losing interest in the project idea and not having the motivation to put in additional effort. The creative momentum seemed to be lost in the transition from in person to remote working and as the ideas evolved.

Secondly, it was interesting to witness architecture students stepping into the role of pitching their solutions, often taking leadership positions within the start-ups. This development is valuable for educators to note in the field of architecture as it varied from the BUILD Solution experience that was predominantly led by the business students. It can be stated that many architecture students already possess valuable leadership skills that can be effectively applied in various contexts, showcasing their willingness to take initiative and engage in continuous learning. Once given the tools to pitch, architects are more than capable of pitching their solutions from a business and design perspective.

Thirdly, since the Living Labs follows an experimental teaching approach, and the same program will be conducted again in 2024, several feedback loops have been incorporated to enable trainers to receive input and enhance the program. These feedback sessions took place in a variety of formats including online surveys, interviews with trainers and students, and in-person feedback sessions integrated within the workshop. The input received covered all aspects of the programme, from workshops, to classes, to team formation with students specifying aspects that worked well and aspects that did not. For example, the presential activities were seen as fundamental for them to build their team and push the ideation process. Within the project, there

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is one partner that is responsible for collecting and analysing the feedback, before presenting it in a report to all the partners with learnings and suggestions. This feedback is a fundamental aspect, as students learn from the faculty just as much as the faculty learn from the students.

Based on the feedback and learnings from the Living Labs 2023, Living Labs 2024 is currently being adapted ready to be implemented in January 2024. This time emphasis is being placed on maintaining the level of motivation between the Kick-off and Closing Ceremony. One suggestion has been to give the students deliverables to make sure they continue to push the development of their ideas; however, as the start-ups develop at different rates, this may need to be adjusted. Furthermore, the team formation will be rethought to attempt to create more balanced teams and to have the solution be at the heart of the team. During the BUILD Solutions project, the team formation was done based on the direction of the solution the students wanted to work on, and each group had two students per discipline. For Living Labs 2024, aspects of the BUILD Solutions team formation will be reintroduced as there were less apparent conflicts than in Urban Shift.

Conclusion

Embracing an experimental teaching approach always poses new challenges. However, it can offer several benefits and opportunities for both the participating students and faculty. While the primary goal of the programme is to establish a supportive and nurturing environment where students receive all the necessary assistance to transform their ideas into viable start-ups, it is probable that only a portion of these start-ups will persist after the programme ends. Nevertheless, in line with the argument of Richardson (2011) and Derry and Fisher (2015), through transdisciplinary start-up education, students can acquire skills that will benefit them throughout their lives, in the job market or in the future starting their own businesses.

Adapting to the needs and challenges of our planet means that architects have to think beyond their discipline, incorporating different perspectives to create impactful solutions. Through these kinds of programmes, architects can become facilitators of transdisciplinary collaborations and establish this approach as a norm within the field. Urban Shift aimed to create a transdisciplinary programme that equips students with abilities that extend beyond the discipline of architecture, complementing their architectural skills and enabling them to redefine the traditional role of an architect.

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