Developing Student's Skills and Competencies in the Field of Architecture, Engineering, and Construction (AEC) Industry 5.0 in Mexico

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***Abstract*— This innovative practice full paper describes implementing a challenge-based learning (CBL) strategy in civil engineering education to develop the discipline competencies needed for the next generation of workers in the Architecture, Engineering, and Construction (AEC) Industry. First, it discusses the challenges and opportunities in the AEC following the 5th industrial revolution and highlights the required competencies. Next, we describe implementing a challenge-based learning (CBL) approach as an educational intervention for skills development in the final semester of a civil engineering program at a private Mexican Higher Education Institution. The challenge for the students was to design project components and plan the construction phase for a real construction company. This challenge encompasses everything from the pavement, hydrological studies, and the potable water network to the structural design of the architectural project. A Building Information Management (BIM) tool was included in the challenge for the first time. The entire process was conducted using the BIM methodology and advanced computational tools. The challenge accounts for the involvement of 16 specialized professors in various study areas, demonstrating the interdisciplinary approach taken in the program. From these experience results, it can be concluded that the students showed a genuine interest in the BIM methodology, which aims to integrate all areas of the construction processes through an organized and transparent workflow to avoid deviations and delays in deliverables. Furthermore, the manuscript explains the sessions with the training partner, emphasizing the importance of collaboration and communication between the students and the industry representatives. This needs negotiation, management, operational, digital, and advanced technical skills, which are aimed to be developed during this CBL intervention. Ultimately, this work highlights challenges, opportunities, and the importance of higher education in preparing students for their impact on the AEC Industry 5.0.**

Keywords— educational innovation, higher education, STEM

I. Introduction

Change in industrial revolutions is happening at an ever-increasing speed [1].

Industry 5.0 (I5.0) has gained attention as a follow-up to Industry 4.0 (I4.0), focusing on human-centered and environmentally friendly approaches. I5.0 emphasizes resilience, sustainability, and the value of new technologies in creating systems that benefit humans [2]. It aims to create welcoming workplaces, strengthen supply networks, and adopt environmentally friendly industrial techniques.

Two traits define the emergence of I5.0. The first concerns harnessing "extreme automation and Big Data with safety, innovative technology policy, and responsible implementation science, enabled by 3D symmetry in innovation ecosystem design." [3] This trait suggests that I5.0 has the potential to make knowledge sharing from Big Data more accessible through innovation and IoT. The second trait is "human-robot co-working," highlighting the importance of boosting productivity in the manufacturing sector without displacing human workers. I5.0 aims to create more jobs than it eliminates [4,5].

Although some other definitions and aspects of I5.0 [6] exist, experts agree that many sectors, such as healthcare, supply chain, construction, and manufacturing, will benefit from advances brought by I5.0, including a sustainability focus [7]. Nowadays, agencies such as the European Commission, are conducting initiatives [8] for action toward the implementation of I5.0, such as adopting proposals for regulating technologies, including artificial intelligence (AI), to a more human-centric approach; creating a skills agenda and a digital education action plan for up-skilling and re-skilling workers; transitioning to a circular economy through a Green Deal with resource-efficient and sustainable industries; and incentivizing an industrial strategy to speed up investment in research and innovation to be globally competitive.

A. Skills and Competencies in Industry 5.0

Skills and abilities that help solve problems, evaluate solutions, and improve actions are called competencies. There are numerous techniques for assessing job competencies [9]. Here, the question is, what competencies are required for I5.0? I5.0 turns the physical world into a virtual one [10]. The advent of Industry 5.0 offers organizations the chance to enhance their growth by leveraging the advantages of recent technological disruptions [10]. I5.0 is gaining attention for integrating AI that matches human capabilities [10]. Thus, digital skills are necessary to cope with all these concepts and evolve digital transformation into a human-centered digitalization.

However, other professional, methodological, social, and personal competencies are identified as important to the I5.0 [11]. Some studies have identified the skills and their level of importance in the context of I5.0. Their findings reveal that managerial skills are paramount, followed by operational and advanced technical skills. These studies carry significant implications for both theory and practice, as they provide valuable insights on how to align skills with the demands of I5.0 [12]. Still, this research area is relatively new. Thus, more studies should be conducted to assess the development of workers into the three pillars of I5.0: sustainability, resiliency, and human-centric [6].

B. A special opportunity area for I5.0: The case of Mexico

To tackle the various work-related challenges, Mexico needs a skilled workforce to transfer their professional expertise in I5.0 to the workplace [13]. This workplace is traditionally composed of multinational companies initially established on the northern border but later expanded to central and southern regions through the maquila subcontracting system. Although some companies have progressed from assembly work to more advanced tasks like research and development to stay competitive, a new panorama opens due to the Reshoring effect [14]. Although it is generally unprepared for such prospects, by empowering an educated workforce, the country can rise to the ranks of global value chains [14].

Foreign investors' interest in Mexico is expected to endure [15]. Special economic zones require supporting trade, education, and infrastructure. The construction of manufacturing plants already involved in I5.0 will require managing risks to unlock potential in services trade, e-commerce, investment, and sustainability [16]. This is a good time to implement educational innovations to graduate students with the skills and competencies necessary to succeed in the I5.0, especially in the architecture, engineering, and construction (AEC) sector.

C. AEC I5.0

There is not much information regarding the advances of the AEC industry in the scope of I5.0. Only recently, Ikudayisi et al. [17] reported these advances. They point out that, despite the significance of the AEC industry, it faces challenges such as low productivity, project delays, cost overruns, subpar quality of work, and negative environmental impacts. These issues are attributed to fragmented supply chains and linear workflows, leading to repetitive tasks and conflicting interests among team members [17]. Integration Practices (IPs) have been embraced to address these issues. These practices span design, construction, and project delivery, welcoming technological advancements and incorporating tools such as BIM, digitalization, automation, robotics, and IoT to enhance integration across the project lifecycle [17]. However, research often neglects the interconnectedness of these concepts with the concepts of human-centricity, sustainability, and resilience, calling for exploration into how the AEC industry can align itself with the values of I5.0 [17].

Thus, several significant gaps exist across various thematic areas [17]. For example, the shift from a linear to an inclusive design approach, including structural, mechanical, and electrical components; the integration of design proposals concerning constructability, cost analysis, and the holistic performance of architectural design; the improving of stakeholder relationships, contract administration, and team performance, management frameworks, and digital tools, which must be flexible and applicable in diverse project contexts.

A tool that may serve to manage these processes is Building Information Management (BIM). BIM is a combination of digital tools that enable processes and methodologies that are widely used in the AEC industry. It allows the sharing and transmission of building data throughout the life cycle of a project, from planning through operation and maintenance, by integrating building data and information models [18]. BIM has improved the construction process, but future studies should explore strategies to enhance BIM adoption, especially in different international contexts and with various project methodologies [17].

D. Educational approaches for AEC I5.0

It has been observed that professionals in the AEC industry often lack the necessary training in multidisciplinary collaboration. This inadequacy can lead to decreased productivity and interpersonal conflicts, ultimately hindering the industry from fully capitalizing on the benefits of IPs and technological enablers. AEC professionals must receive adequate training in multidisciplinary collaboration to ensure they are equipped with the necessary skills to work in an increasingly complex and integrated environment [17].

To address this need, researchers have developed frameworks, programs, and courses for adjusting curricula promoting an integrated approach to AEC courses [19, 20]. These frameworks account for an interdisciplinary approach, demonstrating that combining technical and integrated multidisciplinary knowledge is highly valuable for the industry [21, 22]. Furthermore, researchers have advocated revising curricula to include training on BIM, while some software companies, like Autodesk, offer introductory BIM courses at educational institutions [17]. However, effective project delivery in the context of IPs requires training and skill development. Because of this, research opportunities include developing frameworks and guidelines for upskilling AEC professionals to adapt to the changing industry landscape [17].

E. *Motivation and objective of this work*

IR 5.0 emphasizes human-to-machine integration, fostering collaboration and coordination within project teams. BIM technologies are crucial in I5.0 by supporting real objects within a single control loop. Integrating BIM technologies within the context of I5.0 enhances the efficiency and effectiveness of managing construction industrial systems. [23]. BIM processes can be further optimized by leveraging the power of human knowledge and innovative proficiency through machines. However, challenges such as a shortage of technical skills need to be addressed for successful integration [24].

In a constantly evolving world, higher education in AEC faces an exciting challenge: preparing future professionals for the era of I5.0. In this context, there is a need to embrace new educational trends that enable students to acquire the necessary competencies to tackle the challenges of the 21st century. One of these trends is challenge-based learning (CBL).

CBL and Problem-Based Learning (PBL) are both student-centered approaches that tackle real-world issues [25]. CBL focuses on collaborative problem-solving to address challenges, encouraging students to take action and engage globally. In contrast, PBL typically presents a specific problem for students to solve, often within a structured framework [26]. While both methods promote active learning, CBL emphasizes a broader, collaborative problem-solving approach, while PBL focuses on specific issues within a given context. Ultimately, CBL encourages a more holistic and collaborative problem-solving process compared to the more targeted approach of PBL.

The effectiveness of CBL in developing skills demanded by the job market, including sustainable and digital skills, has been highlighted [27]. Therefore, applying CBL in civil engineering education can help students acquire the competencies required in the evolving job market. CBL incorporates interdisciplinary or transdisciplinary approaches, which allows students to develop boundary-crossing competencies and integrate disciplinary perspectives. These approaches offer more open-ended challenges, emphasizing impact and stakeholder involvement [28].

This work explores a CBL approach applied in the final semester of a civil engineering program at a private Mexican university. The objective is to help students develop negotiation, management, operational, and digital technical skills for work integration in a real project and, in turn, to help prepare future professionals to address the challenges of AEC I5.0

II. Methodology

A. *Description of the challenge*

This section explains the planning for developing an integrated semester in the Civil Engineering program involving AEC topics. The semester involved creating a learning challenge for the students.

This challenge tested the students' technical skills and required them to develop competencies beyond academics. From designing transportation infrastructure to efficiently managing construction projects and entrepreneurship in the industry, students demonstrated their ability to address environmental feasibility, sustainability, and negotiation effectiveness.

The challenge was as follows: a group of visionary investors envision creating a residential real estate project in the metropolitan area of Monterrey. As a founding partner, the development company has hired "IC-TEC21 General Contractors" (students) to design project components and plan the construction phase. This challenge encompasses everything from pavement design, hydrological studies, and potable water network design to the structural design of the architectural project. The entire process must also be conducted using the BIM methodology and advanced computational tools.

B. *Implementation of the challenge*

A total of 16 professors planned the classes and semester deliverables. These faculty members are researchers or specialized professors in various areas, as shown in Table I.

TABLE I. TABLE I. STUDY AREAS OF THE PROFESSORS INVOLVED IN THE INTEGRATED SEMESTER.

Study area	No. of Instructors
Infrastructure	3
Hydraulic systems	4
Structures	4
Management	4
BIM	1

The semester planning was organized in 10 weeks, as seen in the Gantt diagram in Fig. 1.

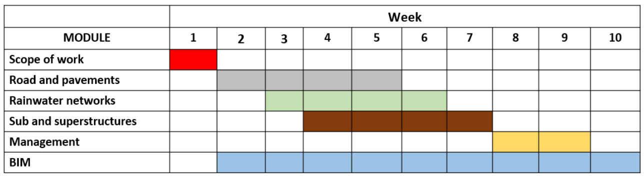

Fig. 1. Gantt Chart of the integrated semester.

As observed, the students took classes on five topics related to developing an integrated construction project. This was the first time project integration was included under the BIM theme.

The first three days of week one, students were dedicated to defining the project scope (deliverables of evidence), structuring the work team, meeting and creating a work plan with the training partner, and ideally, making a site visit to the project or a similar one with the training partner. At the end of the week, the master plan (BIM execution plan) was developed, and negotiation was addressed.

The Infrastructure evidence module covered gradients, pavement design, and sustainability during weeks 2, 3, and 4. In weeks 5 and 6, the focus shifted to hydraulic systems, including rainwater management, the design of the potable water network, and environmental feasibility. The structural evidence was developed during weeks 7 and 8, encompassing the structural design of concrete and steel, foundation, and retaining walls for a clubhouse. In week 9, the project's budget, feasibility, and entrepreneurship were addressed.

Week 10 was centered on the final project management delivery and the final evidence submission. The activity concluded with an assessment session.

C. *Evaluation plan*

The assessment plan consisted of group and individual activities (each assigned a quantitative value), the evidence required to demonstrate the level of competency achievement, and the feedback moments students experienced throughout the Semester. Table II presents the distribution of the final evaluation.

TABLE II. TABLE II. WEIGHTS OF THE SEMESTER ACTIVITIES IN THE FINAL EVALUATION OF STUDENTS.

Evaluation elements	Points
Formative activities	44
Evidence of competencies	56
Total	100

Formative activities were defined as tasks and activities conducted during the semester. Some of these activities had an impact on the final grade. Table III illustrates the points distribution, considering the assessed formative activities.

TABLE III. TABLE III. DISTRIBUTION OF POINTS OF THE FORMATIVE ACTIVITIES.

No	Activity	Points
1	Case Module 2. Estimation of transit demand	5
2	Quiz Module 2 (Infrastructure)	5
3	Quiz Module 3 (Hydraulic systems)	12
4	Quiz Module 4 (Structures)	12
5	Case Study Module 5 (Management)	3
6	Quiz Module 6 (Management)	7
	Total	44

Likewise, the six project pieces of evidence had the values specified in Table IV.

TABLE IV. TABLE IV. DISTRIBUTION OF POINTS OF THE EVIDENCE.

No	Evidence	Points
1	BIM Processes	4
2	Levels/Pavement	12
3	Hydraulic systems/Networks	12
4	Foundation/Structure	12
5	Program/Budget/Entrepreneurship/Feasibility	12
6	Final Report/Presentation	4
	Total	56

D. Sessions with the training partner

The students had to work with a training partner to meet the challenge. The requirements of the training partner were as follows:

- Provide the information on the requested dates.
- Designate a person to assist with coordination.
- Designate, if available, a specialist to provide follow-up.

For this work, the training partners participating in the project are referred to as Organization 1 (O1), Organization 2 (O2), and Organization 3 (O3), each coordinated by a professor. Each company's representative provided the students with the following information: Site Topography, Road Layout, Soil Mechanics Study, Hydrological Study, and Architectural Project.

The students met with the company representatives six times during the semester (twice per month from March to June), as shown in Table V.

TABLE V. TABLE V. SESSIONS WITH THE TRAINING PARTNER.

Session	Description
Start	Development Project Presentation.
Site visit	Site visit to observe construction processes, pavements, potable water network, and architectural project.
Session 1	BEP Evidence, Master Plan, and Effective Negotiation.
Session 2	Evidence of subgrades, pavements, and sustainability.
Session 3	Evidence of rainwater solution, potable water network, and environmental feasibility.
Session 4	Evidence of structural design and foundations.
Session 5	Evidence of budget, feasibility, and entrepreneurship.
Session 6	Final presentation of the challenge.

E. *Data collection and analysis*

This work descriptively analyzes the grades obtained by the students and a preliminary student survey. Likewise, feedback from implementing teachers is analyzed to identify areas for improvement in the educational proposal. With this information, we conclude the usefulness of the CBL approach in preparing civil engineering students for the AEC I5.0.

III. RESULTS AND DISCUSSION

For this project, we focused on developing disciplinary and transversal competencies that graduates should obtain to succeed in the I5.0 (Fig. 2 and Fig. 3).

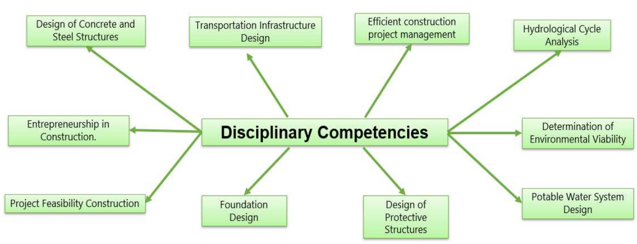

Fig. 2. Disciplinary competencies developed in the Challenge.

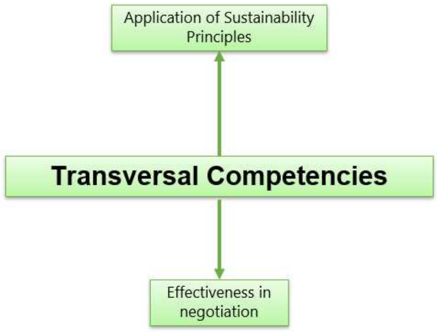

Fig. 3. Transversal competencies developed in the Challenge.

With the information provided by the companies, the students designed the project's roadway (road thicknesses), designed the drains and rain drains, the substructure and superstructure of the assigned project to quantify the total cost of the project, define the scope of construction and the financial feasibility study. With this, the students developed the assessed disciplinary competencies. A total of 18 projects were submitted from 11 teams of students working with O1, three teams working with O2, and 6 working with O3.

The BIM Execution Plan developed by the students was based on the Mexican Regulations NMX-C-527-1-ONNCCE-2017. Through this experience, the students developed negotiation skills as they had to agree with the assigned company on the deliverables to carry out a process. This was done by presenting to the training partner and showing them the deliverables they made in a simulation of a contest in which each team submitted their proposal for the execution and management of the project. Sustainability competencies were developed to comply with the numerical values provided by the client.

Students had to make and follow a defined process flow to meet the client's needs (Fig. 4). Deliverables were presented to the company representatives in the different sessions (Fig. 5).

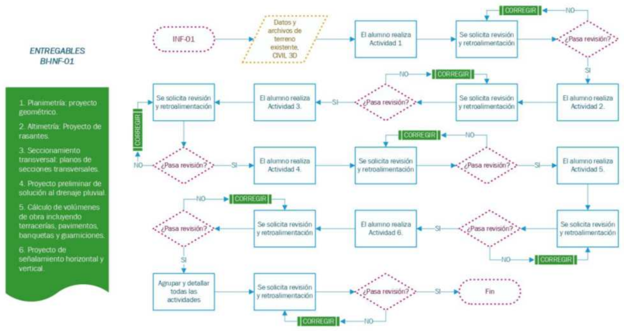

Fig. 4. Example of a process diagram for the BIM execution plan one of the teams developed. The text is in Spanish since the semester was conducted in that language.

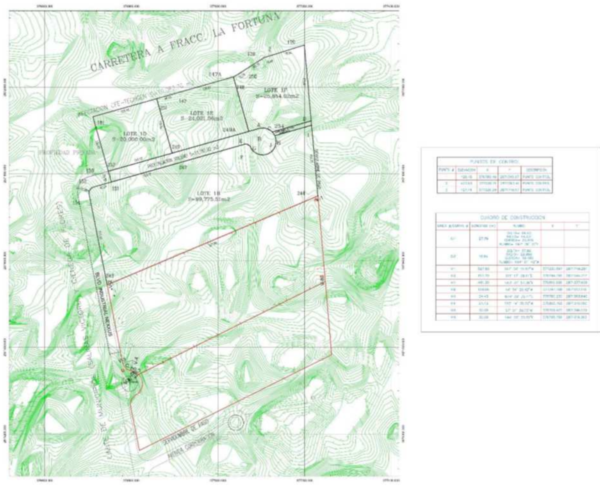

Fig. 5. Example of a topographic plan of the project site of one of the groups working with the O1. The text is in Spanish since the semester was conducted in that language.

Table VI shows the distribution of Civil Engineering students who participated in the first version of the AEC challenge at Tecnológico de Monterrey and the average of the final grades obtained by the group.

TABLE VI. TABLE VI. DISTRIBUTION AND FINAL AVERAGES OF STUDENTS PARTICIPATING IN THE CHALLENGE.

Training partner	Students' distribution			Average (Std. Dev.)
	Male	Female	Total	
O1	26	3	29	95.41 (1.96)
O1	24	2	26	91.85 (2.60)
O2	14	2	16	88.75 (3.71)
O3	24	7	31	85.16 (3.13)

As can be seen, all students obtained passing averages (overall average = 90.34, maximum average = 98, minimum average = 78). The students who worked with the O1 probably obtained better results since the O1 and the teams adhered to the BIM methodology, complying with something as basic as the minutes (Fig. 6), which kept the project in order.

No.	Asunto	Compromisos Acordados	Responsable	Fecha Compromiso
1	Asignación de roles	Aceptar el rol asignado y responsabilizarse del área asignada	Todos	27/03/2023
2	Responsables de asistir a la reunión BIM	Asistir a las reuniones informativas de BIM y compartir al equipo de trabajo, la información y conocimientos adquiridos en las sesiones	[redacted]	28/03/2023-29/03/2023
3	Responsables de asistir a la sesión con el Socio Formador	Asistir a las reuniones informativas del socio formador y compartir al equipo de trabajo, la información y conocimientos adquiridos en las sesiones	[redacted]	28/03/2023
Cierre de minuta: Como primera reunión de equipo, se realizó la primera interacción y asignación de actividades que formarán las bases del curso. Asimismo, se realizó la preparación en base a estos roles para la asistencia a reuniones con socio formador y el curso informativo de BIM.				

Fig. 6. Screenshot of the project minutes required to justify the students' working hours. The text is in Spanish since the semester was conducted in that language.

Each student's development of competencies was assessed in e-Lumen. In this edition of the challenge, all students developed their competencies according to the collegiate assessment. In this case, the training partner did not evaluate the students but only requested the proposal based on their needs. The competencies were developed under continuous feedback and follow-up of preliminary deliverables (A Revisions) to polish them and generate approved documents for construction (0 Revisions) through the Lean Kanban methodology, using Trello software.

Regarding the BIM methodology, this work was the first time we implemented and integrated technology within a final course of the Civil Engineering career. In addition, it is the first generation of a new educational model to graduate. Previously, a Final Degree Project was done. However, BIM was not included. Examples of the implemented software are in Fig. 7.

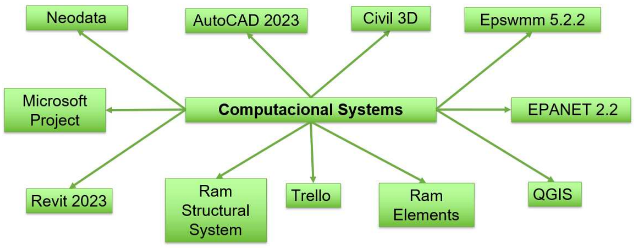

Fig. 7. The software employed in the challenge.

This intervention has been carried out during two consecutive semesters. At the end of the course, a short survey with three questions was sent by mail: (1) From 1 to 10, where 1 is the lowest grade and 10 is the highest, how would you rate the application of the BIM methodology? (2) From 1 to 10, where 1 is the lowest grade and 10 is the highest, applying the BIM methodology was useful for managing the project and solving the challenge. (3) Write in a few lines what you liked most about applying the BIM Methodology in the course and what areas of improvement it has. This questionnaire has 88 answers, averaging 8.41 ± 1.459 and 8.21 ± 1.9133 (min 3, max 10) to the first and second questions. Some answers to the last questions are:

The course imparts a first approach to a BIM Execution Plan, but it didn't work 100% on the deliverables by applying BIM hand in hand.

I enjoyed the organization, transparency, updating, and follow-up.

I learned about the BIM Execution Plan and the coordination that must be conducted with the project members. Learning to use Revit, Mechanical, Electrical, and Plumbing models from earlier semesters would be interesting. To see the use of the methodology in action, for example, how to save documentation to the cloud, changes, etc.

I enjoyed the process. I want to implement more designs to learn about elements such as windows, doors, etc., so that I have a notion of images and not only planes.

That there was more organization in terms of deliverables.

I have the opportunity to design a model in Revit, but I would still like to be immersed in detail about what has to be integrated into a BIM Execution Plan.

It is very good to carry out the issue of the minutes. However, our team did not register them consistently. We often chose to have meetings, but no one was in charge of the minutes.

From these answers, it can be concluded that the CBL intervention, using the BIM methodology, has successfully developed students' skills. In this way, we can conclude that the educational approach helps prepare future professionals to address the challenges of AEC I5.0 by giving them the tools to face real-world situations. This methodology aims to integrate all construction processes through an organized and transparent workflow to avoid deviations and delays in deliverables. In the opinion of the professors, the experience was encouraging since the use of the BIM methodology, where correctly applied, gave positive results.

A. Discussion

In this work, we applied CBL pedagogy supported by the BIM methodology. Through this experience, both students and teachers realized the need to train students in using information technologies relevant to the AEC industry. Specifically, the work highlights the need to develop soft skills, such as effective communication within work teams, necessary for I5.0.

This work is important for two reasons. On the one hand, challenge-driven education engages students in real-life and often time-sensitive challenges from various fields of society and industry [29]. By embracing this approach, students can venture beyond their comfort zones and expand their cross-disciplinary networks, developing practical and creative solutions that align with society and the industry's current and future needs [29]. This results in co-creating new knowledge and developing 21st-century skills relevant to working within an interdisciplinary context characterized by uncertainty, facilitating the development of key competencies [30, 31].

In previous works, CBL has been implemented positively in civil engineering courses. It has been demonstrated that industry-based experiential learning was more effective in developing industry-ready professionals than conventional teaching methods [32]. Recently, a study implemented a CBL model for teaching structural analysis in civil engineering. The model involved collaboration with an industry partner and evaluating student solutions to real case scenarios. The results showed that the participation of the industry partner enhanced the overall experience of students and professors [33].

On the other hand, BIM has been shown to improve learning outcomes in civil engineering courses, effectively improving the learning outcomes of civil engineering majors [34]. A proposal for fully integrating BIM education into civil engineering curricula recommends activities such as CBL, interdisciplinary projects, and case studies to enhance learning outcomes [35]. Implementing BIM technologies in teaching has positively impacted students' perceptions and satisfaction with the academic course [35]. Integrating BIM into a competency-based undergraduate civil engineering curriculum has positively impacted student numbers, graduate employment, and institutional agreements.

Project management methodologies such as this can be implemented in other challenges in other disciplines so that students can integrate learning from different areas of study, thus supporting interdisciplinary learning in engineering and related areas.

B. *Implications and future work*

Researchers have yet to recognize the concept of I5.0 in the construction industry widely. There is a lack of comprehensive conceptualization of this paradigm based on a technology-driven, super-smart society and a human-robot collaboration perspective [2]. The focus should be on human-centered applications that are compatible with the needs of the construction industry.

One of the well-known needs is the solution to the fragmentation issues. Likewise, other challenges to the implementation of new technological trends in construction include [36] resistance to challenge, unclear benefits, and gains, cost of implementation, lack of standardization, lack of skilled labor force, lack of investment in R&D, Data protection, and cyber security issues, legal and contractual problems. In I5.0, a challenge sums up this list, and it is the implementation of sustainable practices and the implementation of new technology. Effective methods can be used to overcome these obstacles and implement smart technologies in the construction sector, such as skilled workforce training, better communication, government incentives, and change management [30]. Higher Education institutions must invest in educational practices that overcome these challenges.

Advancements in digital technology can greatly benefit the construction industry by promoting innovation in the design, construction, and delivery of construction assets to the end user. This can significantly impact the industry by improving the value chain of construction projects, increasing productivity, and enabling safe and sustainable construction practices [37]. The construction industry is starting to adopt innovative technologies such as BIM, Virtual and Augmented Reality, Drone technology, and machine learning worldwide. Higher education practices should include these tools to provide a skilled workforce to the AEC industry.

Challenging students in an artificial intelligence (AI) environment is important in the present context. AI will prevent constructors from relying on traditional methods and techniques, which are prone to stifling productivity [38]. By deploying AI under the support of AEC I5.0 methodologies, costs and construction time can be significantly reduced by minimizing errors and interferences while enhancing accuracy, safety, and efficiency. This work emphasizes implementing AI and digital technologies in AEC courses.

C. *Limitations and future work*

The main limitation of this work is the number of students. So, the strategy will be applied in further semesters to obtain new information. Also, this work validated the Mexican regulation that was used. In future work, it is planned to work with ISO19650, which is the international standard of the BIM methodology. Opportunity areas consist of familiarizing the professors with the BIM methodology, the organization of teachers and students, and more defined scopes by the training partners. In the future, the training partners' opinions about this CBL methodology will be sought to develop the competencies they look for in the students.

IV. CONCUSSION

This work provides an overview of the systematic approach to designing and implementing an integrated final semester of a Civil Engineering career using a CBL approach. When explaining the challenges and opportunities in the AEC industry as it transitions to Industry 5.0, we emphasized the need for competencies in digital skills. We highlighted the importance of integrated practices and technological advancements in the industry. Implementing challenge-based learning and BIM in civil engineering education are promising approaches to prepare students for the evolving landscape. This work underscores the significance of higher education in equipping future professionals with the skills required to succeed in I 5.0, particularly in the AEC sector. Further research will provide valuable insights into the effectiveness of these educational approaches and their impact on the AEC industry's future.

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