ENHANCING BIM COLLABORATION THROUGH LEGO® SERIOUS PLAY®: AN INNOVATIVE APPROACH TO UNIVERSITY

Villa, Valentina
Department of Structural, Geotechnical and Building Engineering, Politecnico di Torino, Italia, valentina.villa@polito.it

Abstract

In the changing educational landscape, new learning methodologies put the focus on active participation, critical thinking and problem solving over traditional passive instruction. This article presents an innovative teaching model implemented at Politecnico di Torino, where LEGO® SERIOUS PLAY® (LSP) methodology was used to enhance discussions and reflections on building information modeling (BIM). Based on experiential learning principles, the workshops encouraged active student participation in collaborative, hands-on activities, using LSP to creatively and interactively explore complex BIM concepts. By creating physical models with LEGO®, participants were able to visualize abstract ideas, communicate their perspectives more effectively, and build a shared understanding of BIM processes and challenges together. This method has proven particularly effective in fostering active learning, critical thinking, and teamwork, which are key skills related to higher-level cognitive processes in Bloom's taxonomy.

Keywords*: learning methodologies, active learning, critical thinking, Lego® Serious Play® (LSP), building information modeling (BIM), collaboration*

Resumen

En el cambiante panorama educativo, nuevas metodologías de aprendizaje ponen el foco en la participación activa, el pensamiento crítico y la resolución de problemas por encima de la instrucción pasiva tradicional. Este artículo presenta un modelo de enseñanza innovador implementado en el Politécnico de Turín, donde se utilizó la metodología LEGO® SERIOUS PLAY® (LSP) para mejorar las discusiones y reflexiones sobre la modelización de la información para la edificación (BIM). Basado en los principios del aprendizaje experiencial, los talleres fomentaban la participación activa de los estudiantes en actividades colaborativas y prácticas, utilizando el Lego® Serious Play® para explorar de manera creativa e interactiva conceptos BIM complejos. Al crear modelos físicos con LEGO®, los participantes pudieron visualizar ideas abstractas, comunicar sus perspectivas de manera más eficaz y construir juntos una comprensión compartida de los procesos y desafíos del BIM. Este método ha demostrado ser particularmente eficaz para fomentar el aprendizaje activo, el pensamiento crítico y el trabajo en equipo, que son habilidades clave relacionadas con los procesos cognitivos de mayor nivel en la taxonomía de Bloom.

Palabras clave: *metodologías de aprendizaje, aprendizaje activo, pensamiento crítico, Lego® Serious Play® (LSP), modelado de información para la edificación (BIM), colaboración*

Introduction

The integration of innovative teaching methodologies in higher education is essential for fostering deep learning and collaboration among students. Rooted in Bloom's Taxonomy, which emphasizes progression from basic knowledge acquisition to higher-order thinking skills such as analysis, evaluation, and creation, active learning methods have gained prominence. Among these, hands-on activities have been shown to enhance cognitive engagement and understanding. This principle aligns with the concept of "learning by doing", where tactile experiences reinforce conceptual comprehension (Wheeler, 2020).

Over the past few years, several efforts have been undertaken to create more effective methods for providing engineering students with the necessary problem-solving skills (Wankat and Oreovicz, 2015). Laboratory activities, among other approaches, are valuable for teaching and advancing knowledge and education. The literature emphasizes the importance of students being actively engaged beyond mere listening, participating in higher-order tasks (Bonwell and Eison, 1991). In science, technology, engineering, and mathematics (STEM) courses, active learning enhances conceptual understanding and problem-solving skills, as evidenced by improved test scores (Hake, 1998). It also fosters positive attitudes and increased persistence in group settings (Springer et al., 1999), and disproportionately benefits students from disadvantaged backgrounds and female students in male-dominated fields (Freeman et al., 2014).

Bloom's taxonomy provides an effective framework for categorizing learning objectives in education, spanning cognitive, affective, and psychomotor domains (Bloom et al., 1956). It is commonly used to design educational processes that promote advanced thinking, such as analyzing and evaluating concepts, rather than simply memorizing facts. The revised version of Bloom's taxonomy (Anderson et al., 2001) introduces more active forms of thinking, with updates to the cognitive domain (Clark, 2004). Modern teaching techniques aim to motivate educators to integrate all three domains, fostering a holistic educational model that encompasses the entire learning process, rather than focusing on isolated specializations.

Lego® Serious Play® (LSP) is an innovative methodology designed to stimulate creative thinking, foster collaboration, and enhance problem-solving using LEGO® bricks. Initially developed for corporate environments, LSP has found applications in diverse fields, including education, where it serves as a tool for engaging students in participatory and reflective learning processes. The core philosophy of *Lego® Serious Play®* is grounded in constructivism and constructionism. Constructivism posits that knowledge is actively constructed by learners rather than passively received, while constructionism emphasizes the role of tangible objects in facilitating this process. By leveraging these principles, *Lego® Serious Play®* transforms abstract ideas into physical models, making complex concepts more accessible and promoting shared understanding within teams.

The *Lego® Serious Play®* method, developed by (Victor et al., 2002), utilizes LEGO® bricks within a guided environment to foster exploratory learning. This approach is rooted in (Piaget, 1954)'s constructivist theory. The concepts of play and flow (Primus & Sonnenburg, 2018), along with the constructionist link between cognition and hands-on activity (Dann, 2018), and the crucial role of metaphors in shaping meaning, form the theoretical foundation of this methodology.

Metaphorical thinking is stimulated by the creativity induced by play, which helps illustrate ideas, leading to new meanings and ultimately to constructivist learning. *Lego® Serious Play®* transforms learning into an experiential process. The workshops are structured into four phases: challenge presentation, building time, meaning sharing, and reflection (Blair & Rillo, 2016). The entire process is led by a facilitator, who plays a significant role in the first and last phases, while the building and meaning-sharing phases are primarily participant-driven. The recommended time for each phase varies depending on the challenge and the depth the facilitator intends to reach (Blair & Rillo, 2016).

1. **State of the Art**

Although there are no direct examples of *Lego® Serious Play®* applied to BIM education at universities, adapting this methodology could be an interesting option to enhance learning and collaboration in information modeling courses, strengthening the soft skills necessary for teamwork, coordination, and cooperation.

In 2011, (Bulmer, 2011) applied *Lego® Serious Play®* in the "Technology Management and Entrepreneurship" program at the University of New Brunswick to stimulate creativity, innovation, and collaboration among engineering students, improving problem-solving and teamwork through LEGO® bricks. In 2021, (Lopez-Fernandez, 2021) conducted workshops with 242 computer science students, using *Lego® Serious Play®* to teach software engineering concepts in a playful and active manner, enhancing motivation, learning, and the development of transversal skills. In 2023, (Benesova, 2023) implemented *Lego® Serious Play®* in a university management module, highlighting its benefits in participatory and co-creative education. Supported by music, LSP improved students' learning and management skills. Another example is (Vahid, 2024), who utilized *Lego® Serious Play®* to facilitate and enhance organizational decision-making processes through a conceptual framework.

Despite the lack of specific research examples on *Lego® Serious Play®* applied to BIM education at universities, inspiration can be drawn from similar applications in other educational contexts.

In the context of Building Information Modeling (BIM), a methodology that requires interdisciplinary collaboration and complex information management, *Lego® Serious Play®* offers a unique approach to enhancing team dynamics. BIM relies on effective communication, coordination, and cooperation among stakeholders to optimize design and construction processes. However, fostering such collaboration can be challenging due to varying levels of expertise and communication barriers within project teams. *Lego® Serious Play®* addresses these challenges by creating a non-threatening environment where participants can express ideas visually and verbally, leading to improved mutual understanding and team cohesion (Kriszan, 2024).

Several studies have demonstrated the effectiveness of *Lego® Serious Play®* in educational settings. For instance, (Cullum, 2019)'s research on using LEGO® for exploring historical concepts in higher education revealed that students engaged more actively in discussions and demonstrated a deeper understanding through hands-on model building. Similarly, (Kawahara, 2019)'s experiments with LEGO-based historical reconstructions highlighted the potential of tactile learning to enhance cognitive and social skills. These findings suggest that *Lego® Serious Play®* can be a valuable tool for teaching BIM concepts, enabling students to visualize complex workflows and fostering collaboration essential for real-world projects.

This paper investigates the application of *Lego® Serious Play®* in a university workshop focused on BIM modeling and collaboration. By exploring its potential to enhance teamwork and improve the design process, this study aims to contribute to the growing body of research on innovative teaching methods in architecture and engineering education. Specifically, it examines how *Lego® Serious Play®* can bridge gaps in communication and coordination within BIM teams while promoting critical thinking and creativity. Integrating *Lego® Serious Play®* into BIM modeling courses can represent an innovative approach to improving collaboration, understanding complex concepts, and developing the essential skills required in the construction industry.

In the "*Gestione del Cantiere e del Progetto*" and "*Project and Site Management*" master's degree courses at Building engineering at Politecnico di Torino, we experimented with using LEGO to stimulate creative thinking and collaborative processes. With the support of Starching, the *Lego® Serious Play®* for BIM (LSP4BIM) methodology enabled students to "think with their hands," engaging them in a collective decision-making process. Targeted exercises were designed to encourage a shared solution by integrating individual perspectives, fostering a structured and cohesive approach to information modeling and collaborative workflows. These skills are essential for effectively embracing digital transformation in the construction sector. Incorporating play into university classrooms transformed communication dynamics and increased engagement levels, making all participants active contributors to the learning experience.

2. **Development of Educational program**

The *Lego® Serious Play®* method is based on three fundamental principles: construction, storytelling, and reflection. These principles can be applied to facilitate BIM learning, enhancing the understanding of 3D models and improving communication among design teams.

- **Construction:** Using LEGO bricks to create models representing BIM concepts, such as buildings or infrastructure, helps students visualize and better understand complex structures.
- **Storytelling:** Participants explain the meaning of their models, sharing their perspectives and ideas, thereby improving communication and collaboration.
- **Reflection:** Analyzing the built models and identifying common themes fosters critical thinking and deep learning.

Lego® Serious Play® can be used to enhance collaboration among students, fostering a more cohesive and productive working environment. By constructing LEGO models, students can explore different perspectives and develop a deeper mutual understanding, enhancing team building and collaboration. Moreover, this method allows students to visualize BIM processes: using LEGO bricks to represent workflows and BIM process phases can help students better grasp how different disciplines interact throughout a project.

In addition, *Lego® Serious Play®* serves as a problem-solving technique: it can be employed to address common BIM challenges, such as data management and interoperability between different software. Constructing LEGO models representing these challenges can facilitate discussions and the search for innovative solutions.

The *Lego® Serious Play®* methodology was therefore integrated into the educational program of two master's degree courses in Building Engineering at Politecnico di Torino during the 2022/2023 academic year. Specifically, two dedicated sessions were organized: one for the "*Gestione del Cantiere e del Progetto*" course, part of the "*Resilienza del Costruito*" master's program, delivered in Italian to a class of 15 students, and one for the "*Project and Site Management*" course, part of the "*Green Building*" master's program, taught in English to an international class of approximately 78 students, 38 of whom participated in the activity.

Both courses provide an overview of the construction process and project management strategies, from the design phase to on-site construction. Undoubtedly, BIM supports all phases, and collaboration has become an essential element, both for the group projects students are required to carry out during the semester and in their future professional careers.

For this reason, the Lego Serious Play methodology was introduced as an innovative teaching tool, aiming to shift perspectives, encourage alternative approaches to problem-solving and reflection, bring play into university classrooms, and transform traditional lectures into shared discussions.

The activity described below was designed and implemented in collaboration with architect Leonardo Previ, a certified *Lego® Serious Play®* facilitator and founder of Trivioquadrivio, an Italian consulting firm specializing in corporate training, organizational development, and innovation. For over 25 years, he has been designing and facilitating learning experiences based on creative and experiential methodologies.

Support for its application in the field of information modeling was provided by Matteo Giani, consultant and BIM Manager at Starching, an Italian engineering and architecture firm specializing in integrated design, BIM (Building Information Modeling), and the management of complex projects. The company offers consulting and development services for buildings, infrastructure, and urban planning, combining digital innovation with sustainability.

A full-day workshop was organized for each specialization course. The goal of the workshop was to understand how BIM has been integrated into students' workflows and how they perceive modeling and the transformations that BIM use entails in relationships between colleagues, specialists, and stakeholders.

3. **Daily Schedule**

The two sessions took place on April 18, 2023, for the Italian-taught course and on May 31, 2023, for the English-taught course. The workshop structure was the same for both classes:

- 09:30 - 10:00 Introduction to the LSP4BIM methodology
- 10:00 - 11:00 Skills building (preparatory exercises)
- 11:00 - 11:30 Core identity 1: participants individually build a model representing the key feature of architectural design.
- 11:30 - 12:00 Core identity 2: participants individually build a model representing the key feature of BIM.
- 12:00 - 13:00 Positioning (participants place their models on the table to create an initial business landscape) and faculty feedback.
- 13:00 - 14:00 Lunch break
- 14:00 - 14:30 Agent 1: participants individually build a model representing the agent with the most positive impact on the landscape.
- 14:30 - 15:00 Agent 2: participants individually build a model representing the agent with the most negative impact on the landscape.
- 15:00 - 16:30 Faculty intervention to comment on and integrate the results obtained by the participants.

4. **Working groups**

The first session took place in the "Gestione del Cantiere e del Progetto" course, taught in Italian, with a total of 15 participants divided into two groups. The first group consisted of 8 females, while the second group included 6 females and 1 male.

The second session was held in the "Project and Site Management" course, in the international English-taught class, with a total of 23 participants divided into three groups. The first group consisted of 8 males, the second of 6 males and 1 female, and the third of 7 males and 1 female.

Table 1. Composition of the working groups for the two courses, including the number of male and female participants in each group

	Italian course		**International course**		
Group number	***Team 1***	***Team 2***	***Team 1***	***Team 2***	***Team 3***
Male	1	0	8	6	7
Female	6	8	0	1	1
Number of participants per group	**7**	**8**	**8**	**7**	**8**

Fig. 1: Photo of participants: left Italian course and right international course.

Emerging from the keywords below, an interesting observation emerged when considering the gender distribution within the two workshop groups. In the Italian course, which had most female participants, the discussions and models tended to focus more on collaborative aspects and the management of information flows. Students emphasized teamwork, communication, and the importance of shared understanding in BIM processes.

On the other hand, the international course, predominantly composed of male participants, showed a stronger inclination toward technological themes, including the use of digital twins, sensors, and advanced interoperability concepts. While this distinction does not imply a rigid division of interests, it highlights how

group composition may subtly influence the orientation of discussions and the emergence of specific topics during creative, hands-on activities.

The preparatory exercises warmed up the classroom, creating a nice transformative atmosphere and putting the students at ease. They were games exemplifying the essence of the *Lego® Serious Play®* methodology, i.e., doing before thinking, thinking with hands.

In "*Core identity 1*" participants, on an individual basis, had to represent an aspect related to engineering design. With limited time and having the LSP kit at their disposal, they then gave meaning to their construction, illustrating it to the classroom and summarizing the concept they had in mind on a post-it note. Table 2 shows the key words that emerged in the distinct groups:

Table 2. Key features of architectural design

Italian course		**International course**		
Team 1	***Team 2***	***Team 1***	***Team 2***	***Team 3***
Linearity	Spaces and people	Simmetry	Confort	Relationship
Innovation	Overcoming limits	Team working	Safety	Multipath
Structural nodes	Balance	Foundation	Innovation	Energy
Shielding	Safety	Technology	Beyond	Harmony
Design	Future	Innovation	Decoration	Equilibrium
Ease of use	Stability	Sustainability	Control	Elevation
Accessibility	Collaboration	Team working	Art	Architecture
	Quality	Transportation		Survey

The use of physical models truly conveys the idea of concepts that are sometimes very abstract, such as communication, management, lack of organization, etc. To illustrate how effective this methodology is when applied to the BIM management of processes, some images are provided of the objects created during the workshop, inspired by the ideas previously discussed in class. The concept of forward-looking design, embracing innovation, is well represented by spaceships.

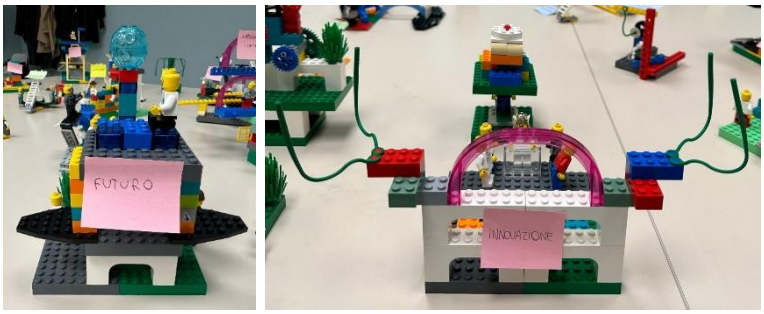

Fig. 2: Photo of two LEGO models of key features of architectural design

In "*Core identity 2*" participants, on an individual basis, had to represent an aspect related to BIM (Building Information Modeling). With limited time and having the *Lego® Serious Play®* kit at their disposal, they then gave meaning to their construction, illustrating it to the classroom and summarizing the concept they had in mind on a post-it note. Table 3 shows the key words that emerged in the distinct groups:

Table 3. Key features of BIM

Italian course		**International course**		
Team 1	***Team 2***	***Team 1***	***Team 2***	***Team 3***
Cooperate	Interoperability	Interoperability	Knowledge	Digital Twin
Cooperation	Decisions	Team working	Process	Sensors
Integration	Durability	Communication	Interoperability	Simulations
Sharing	Collaboration	Composable	Trasparency	Connection
Interoperability	Learning	Stability BIM	AIM	LCA
Process	Dynamism	Thinking	Completeness	Modular
Information	Information	Data Collection	Mindset	Unity
	Coordination	Evolution		Team work

In the analysis of BIM, models of collaboration, connection, and communication emerge. There are figures looking at each other, working at the same table, following the same path, and being connected by a thread.

The visualization also includes characters who, if unwilling to collaborate, turn into skeletons, as shown in Fig. 4.

Fig. 3: Photo of two LEGO models of key features of BIM

At this point, the elements that emerged in the more traditional view of the building process and BIM had to be structured and positioned to create a shared and unified discourse for the group.

Remarkably interesting elements emerged, both in terms of planimetric organization (some thought of a hexagon, some a linear path, some a city with a center and many streets branching off from the central square). Personal visions mixed with a common thought, a clear sign of how this methodology, highly creative but with very precise timing and rules, leads to a result shared by the team in a brief time.

Fig. 4: Photo of three different landscape arrangements that combine the key features of architectural design and BIM: linear (on the left), city-shaped with a central square (in the middle), and hexagonal (on the right).

After a break, we moved on to the third part of the work: In "*Agent 1*" the participants, on an individual basis, had to represent a positive agent on the landscape presented in the morning. With limited time and having the *Lego® Serious Play®* kit at their disposal, they then gave meaning to their construction, illustrating it to the classroom and summarizing the concept they had in mind on a post-it note. Table 4 shows the key words that emerged in the distinct groups:

Table 4. Meaning of models representing the agent with the most positive impact on the landscape

Italian course		**International course**		
Team 1	***Team 2***	***Team 1***	***Team 2***	***Team 3***
Knowledge	Compare	Innovation	Fusion	Climate change
Creativity	Agreement	Collaboration	Technology	Governance
Investment	Teamwork	Efficiency	Step by step	Efficiency
Process time	Training	Development	Evaluation	Communication
Sustainability	Management	Infrastructure	Leadership	Cooperation
Money	Communication	Coordination	Expertise	Time
Construction time	Sustainability	Strategy	Integration	Budget
	Specialized planning	Implementation		Technology

For the third part, dedicated to models representing the agent with the most positive impact on the landscape, the most significant one is shown in Figure 5, where the paradigm shift is clearly visualized. From individuals initially focused on their own goals, two staircases at the center connect and create unity. It is not an easy path—it is an uphill climb for both—but there is a concrete opportunity for effective communication, thanks to the use of innovative technologies.

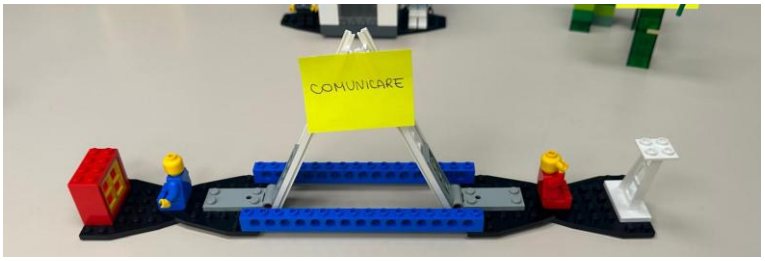

Fig. 5: Photo of a model representing the agent with the most positive impact on the landscape

In "*Agent 2*" the participants, on an individual basis, had to represent a negative agent on the landscape. With limited time and having the *Lego® Serious Play®* kit at their disposal, they then gave meaning to their construction, illustrating it to the classroom and summarizing the concept they had in mind on a post-it note. Table 5 shows the key words that emerged in the distinct groups:

Table 5. Meaning of models representing the agent with the most negative impact on the landscape

Italian course		**International course**		
Team 1	***Team 2***	***Team 1***	***Team 2***	***Team 3***
Difficulty in making teams	Bureaucracy	Inefficiency	Lack of teamwork	No safety
Inconsistency	Economic losses	Delay	Lack of coordination	Economic losses
Different languages	Setbacks	No Planning	Time	No communication
Non-observation of rules	Traffic accidents	Regulatory issue	Budget overrun	Money
Structural instability	Time (haste)	Lack of trasparency	No scheduling	Time Waste
Lack of coordination on site	Disinformation	Cultural barriers	Confusion	Inefficiency
Business failure	Disregard	Confusion	Bureaucracy	No common rules
	Lack of updating	Financial problems		Interoperability

Regarding the negative aspects, we find a lack of coordination, represented by staircases leading to nowhere, positioned in different points of space, and skeletons moving along paths without clearly knowing where to go. The use of different languages creates dividing walls, highlighting the absence of effective teamwork, with characters searching for a path in completely opposite directions.

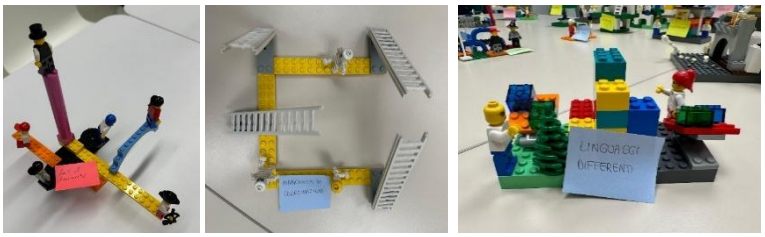

Fig. 6: Photo of a model representing the agent with the most negative impact on the landscape

5. **Results and feedback**

To enhance the clarity and impact of the findings, a summary table consolidate the key results from each activity (e.g., Core Identity 1 and 2, Agents 1 and 2). Table 6 would synthesize the concepts that emerged during the workshops, providing a clear and concise comparison across separate groups and activities. By presenting the data in a structured format, the table would facilitate a better understanding of the recurring themes and unique insights generated by the participants, highlighting the effectiveness of the Lego® Serious Play® methodology in fostering collaboration and critical thinking within BIM education.

Table 6. Summary table that consolidates the key results from each activity

Workshop Activity	**Focus Area**	**Key Themes (Italian Course)**	**Key Themes (International Course)**	**Observations**

Core Identity 1	Architectural Design	Linearity, Innovation, Stability	Symmetry, Sustainability, Collaboration	Emphasis on structure, harmony, and user experience
Core Identity 2	BIM Concepts	Cooperation, Communication, Interoperability	Digital Twin, Teamwork, Information	Strong focus on process integration and teamwork
Agent 1	Positive Influences	Creativity, Agreement, Efficiency	Innovation, Sustainability, Communication	Communication and innovation seen as key enablers
Agent 2	Negative Influences	Bureaucracy, Time Waste, No Teamwork	Inefficiency, Lack of Coordination, Confusion	Common issues: delays, miscommunication, unclear roles

The feedback from the students after the workshop highlighted several key takeaways. First, the importance of communication was emphasized, with students recognizing the value of never turning their backs on each other and having the courage to take responsibility. They also reflected on the need for commitment and effort in performing one's tasks effectively. The workshop underscored the significance of multidisciplinary knowledge and the role of clear, critical thinking in producing quality projects. Students also highlighted the importance of sharing a common vision to achieve goals. Furthermore, communication was identified as essential for reaching objectives, as it involves the exchange of ideas and collaboration, with participants stressing that people must actively engage with one another. Finally, brainstorming was seen as a vital tool, with students acknowledging that communication and idea-sharing are far from a waste of time.

The students appreciated several aspects of the workshop. They highlighted the sequence of exercises and the concept of using Lego to relate to BIM, which allowed for hands-on interaction and practical learning. They value team collaboration and idea-sharing, recognizing that each individual's actions contributed to the final result. Many students appreciated how the models were unified to explore the connections between them.

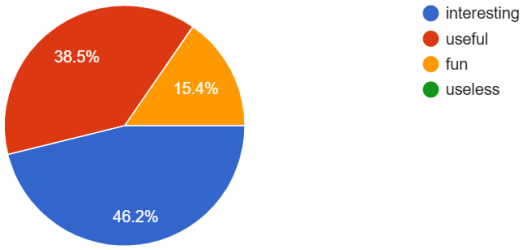

Fig. 7: The results to the question "How do you evaluate the workshop?"

The inclusivity and focus on creating a powerful performance stood out as a key aspect of the workshop, demonstrating the effectiveness of the methodology from the start. Creativity, group activities, and the opportunity to work with the thoughts of other engineers were also valued. Finally, students enjoyed the freedom to create without overthinking, which helped them understand the subconscious aspects of BIM, as well as the critical thinking and creativity involved in naming Lego shapes and creating stories around them.

Both days were rich in energy and content. The feedback from the students was overwhelmingly positive, with all participants expressing a favorable opinion to the question "Do you think it was a worthwhile experience?" and the majority deemed the sessions both useful and engaging.

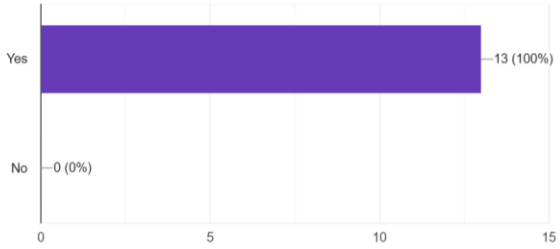

Fig. 8: The results to the question "How do you evaluate the workshop?"

Overall, the students did not highlight any aspects they disliked, except for one comment suggesting that it would have been better if the teams were chosen randomly, and a mention regarding the date of the workshop.

They mostly appreciated the hands-on, "learn by doing" approach, which contrasted with the typical theoretical and passive learning methods, helping to engage their subconscious and improve creative thinking, problem-solving, and communication. Many found it both interesting and fun, and it helped them understand their unconscious thoughts about BIM better. The workshop also broadened their horizons, addressing topics not typically covered in engineering degrees, and promoting creativity and team bonding. They valued the opportunity to work with new ways of group thinking and problem-solving.

The workshop made them reflect on various aspects, including how the exercises were connected and the importance of collaboration to achieve goals. Students realized that different people could have unique ideas, yet still arrive at similar outcomes. They were struck by how many different solutions and perspectives can emerge from the same topic. Some students noted that the exercise highlighted the theoretical nature of engineering and the industry's need for more practical, enjoyable approaches. The workshop also encouraged participants to tap into their creativity and think about how the meaning we assign to things shapes their outcome, emphasizing the value of collaboration and creating methodologies from their team's perspective.

The students expressed positive emotions throughout the workshop. Many felt calm, happy, and interested, with several noting that they were engaged in the activities, having fun and not wasting time. Some described feeling relaxed yet energized, excited, and amused, with one student commenting that "time flies." Overall, the atmosphere was described as great, and students felt highly active and focused during the experience.

In terms of group work, students generally had a positive experience. Cooperation was highlighted as good, with many mentioning that communication and collaboration went well. Some students appreciated the chance to listen to each other, share ideas, offer advice, and elevate each other's thinking. One student described the group experience as "perfect," emphasizing the mutual support in refining the model. The overall group dynamic was seen as enjoyable, with a great atmosphere that fostered creativity and collaboration, despite some occasional challenges.

To further contextualize this experience within the broader landscape of software studies, it is valuable to draw comparisons with other pedagogical innovations such as gamification. Both Lego® Serious Play® and gamification aim to increase student engagement and foster active participation. While Lego® Serious Play® relies on tangible, collaborative construction and metaphoric storytelling, gamification introduces game elements like points, badges, and challenges to motivate learners. In the context of BIM education, gamified approaches—such as simulation-based scenarios or competitive team-based modeling—could complement Lego® Serious Play® by reinforcing decision-making under constraints, a crucial skill in real-world project environments.

Additionally, the LSP4BIM methodology shares several principles with the Project-Based Learning (PBL) approach. Both methods emphasize active student engagement, interdisciplinary collaboration, and real-world problem solving. Integrating Lego® Serious Play® into a broader Project-Based Learning framework could further enhance the learning experience, by allowing students to iteratively develop solutions to open-ended design challenges while also reflecting on their collaborative processes. This integration could be particularly powerful in multidisciplinary AEC courses, where students must synthesize knowledge across domains.

From an assessment perspective, experiential methods like LSP often challenge traditional evaluation metrics. To address this, hybrid assessment tools can be adopted. For example, combining physical modeling activities with digital splash-screen assessments, typically used in online learning environments, can offer a richer picture of student understanding. Splash-screen tools can be used to prompt immediate reflection and self-evaluation after each phase of the workshop. Additionally, combining LEGO models with online collaborative platforms (e.g., Padlet, Miro) could help document the evolution of group thinking, capture non-verbal contributions, and facilitate asynchronous peer feedback. Such mixed approaches not only enhance inclusivity and accessibility but also support a more formative assessment model, focusing on student growth, collaboration, and process awareness rather than only on outcomes.

6. **Conclusion**

The integration of *Lego® Serious Play®* into university-level BIM education, as explored through workshops at Politecnico di Torino, demonstrates a promising avenue for enhancing collaborative learning and critical thinking skills. This study aimed to investigate the potential of *Lego® Serious Play®* to address the inherent challenges in BIM education, specifically focusing on improving team dynamics, communication, and the comprehension of complex processes. The findings from these workshops offer valuable insights into the effectiveness of experiential learning methodologies in preparing students for the collaborative demands of the Architecture, Engineering, and Construction (AEC) industry.

The primary observation from the implementation of LSP4BIM is the significant increase in student engagement and active participation. Traditional lecture-based instruction often struggles to foster a sense of shared understanding and can be limited in its ability to cater to diverse learning styles. In contrast, the hands-on nature of *Lego® Serious Play®* encourages students to actively construct their understanding of BIM concepts through physical models. The act of building with LEGO® bricks allows for the tangible representation of abstract ideas, making them more accessible and facilitating deeper cognitive processing.

Furthermore, the storytelling component of *Lego® Serious Play®* proves instrumental in promoting effective communication within BIM teams. By articulating the meaning behind their models, students are compelled to share their perspectives, negotiate ideas, and build a collective narrative. This process helps to break down communication barriers, foster empathy, and create a more inclusive environment where all voices are heard and valued. The ability to articulate one's ideas and understand the viewpoints of others is crucial in the context of BIM, where interdisciplinary collaboration is paramount. The reflection phase of the *Lego® Serious Play®* workshops provides an opportunity for students to critically analyze their models and identify common themes and insights. This reflective process encourages higher-order thinking skills, such as analysis, evaluation, and synthesis, which are essential for effective problem-solving in the AEC industry. By reflecting on their experiences, students are able to consolidate their learning, identify areas for improvement, and develop a more nuanced understanding of the complexities of BIM.

The workshops highlighted the potential of Lego® Serious Play® to foster a more playful and creative learning environment. The use of LEGO® bricks makes the learning process more fun, reducing anxiety and promoting a relaxed, open atmosphere. This encourages students to take risks, experiment with innovative ideas, and think innovatively, which is highly valued in the AEC industry, where adaptability and innovation are crucial. Despite the positive findings, certain limitations should be acknowledged, such as the small sample size and the need for further research to validate these results on a larger scale and in diverse educational contexts. Additionally, the assessment of learning outcomes was mainly based on qualitative observations, and future studies could benefit from incorporating quantitative measures. Despite these limitations, the study provides valuable insights into the effectiveness of Lego® Serious Play® as an innovative teaching methodology for BIM education. The findings suggest that it can enhance student engagement, promote effective communication, stimulate critical thinking, and create a more creative learning environment. By integrating Lego® Serious Play® into BIM curricula, educators can better prepare students for the collaborative demands of the AEC industry and equip them with the skills needed to thrive in the rapidly evolving digital landscape. In conclusion, the integration of Lego® Serious Play® into BIM education represents a significant step toward a more engaging, collaborative, and effective learning experience. Further research and experimentation in this area are crucial to fully unlocking the potential of Lego® Serious Play® and other experiential learning approaches in BIM education.

7. **Future applications**

The potential future applications of the Lego® Serious Play® methodology in BIM education are broad and transformative. Integrating Lego® Serious Play® into BIM courses can create immersive learning environments that foster creativity, critical thinking, and collaboration. Future applications could include advanced workshops where students address real-world BIM challenges, such as project coordination and conflict resolution, using LEGO® models to visualize and solve problems. Incorporating digital LEGO® tools

could also expand Lego® Serious Play® 's reach, making it suitable for remote and hybrid learning environments. Continuous refinement through feedback and research will ensure its ongoing effectiveness.

Combining Lego® Serious Play® with other teaching methods, such as virtual reality and gamification, can further enhance the learning experience, equipping students with the skills needed to meet the evolving demands of the AEC industry. Additionally, Lego® Serious Play® can encourage collaboration across disciplines within the AEC industry. Joint workshops involving architecture, engineering, and construction management students can help address interdisciplinary BIM challenges, fostering a holistic understanding of the construction process. Integrating Lego® Serious Play® with active learning methods, such as Problem-Based Learning and case studies, can create a comprehensive educational experience that strengthens critical thinking, problem-solving, and teamwork skills. By implementing strategies like these, educators can fully leverage the potential of Lego® Serious Play® to enhance BIM education and prepare students for the collaborative and interdisciplinary demands of the AEC industry.

8. **Acknowledgments**

I would like to express our sincere gratitude to Leonardo Previ, President of Trivioquadrivio, for his guidance, expertise, and for providing the necessary tools for the successful implementation of the workshop. My sincere thanks also go to Matteo Giani, BIM Manager at Starching, for his valuable support and contributions. Without their dedication and commitment, this wonderful experience would not have been possible. I am also grateful to the master's degree students of the "Project and Site Management" and "Gestione del Cantiere e del Progetto" courses of Politecnico di Torino, for stepping up to the challenge and for their enthusiastic participation in the proposed activities.

References

Anderson, L. W., D. R. Krathwohl, P. W. Airasian, K. A. Cruikshank, R. E. Mayer, P. R. Pintrich, J. Raths, and M. C. Wittrock. (2001). A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives. New York: Pearson, Allyn & Bacon.

Benesova, N. (2023). LEGO® Serious Play® in management education. *Cogent Education*, *10*(2). https://doi.org/10.1080/2331186X.2023.2262284

Blair, S., & Rillo, M. (2016). SERIOUSWORK: How to facilitate meetings & workshops using the LEGO® serious Play® method. ProMeet.

Bloom, B., M. D. Engelhart, E. J. Furst, W. H. Hill, and D. Krathwohl. (1956). Taxonomy of educational objectives. Handbook I: The cognitive domain. New York: Longmans.

Bonwell, C., and J. Eison. (1991). Active learning: Creating excitement in the classroom. AEHE-ERIC Higher Education Rep. No. 1. Washington, DC: Jossey-Bass.

Bulmer, L. (2011). THE USE OF LEGO ® SERIOUS PLAY IN THE ENGINEERING DESIGN CLASSROOM. Proceedings of the Canadian Engineering Education Association (CEEA). https://doi.org/10.24908/pceea.v0i0.3699

Clark, D. R. (2004). "Bloom's taxonomy of learning domains." Accessed July 18, 2018. http://nwlink.com/~donclark/hrd/bloom.html.

Dann, S. (2018). Facilitating co-creation experience in the classroom with lego serious Play. Australasian Marketing Journal, 26(2), 121–131. https://doi.org/10.1016/j.ausmj.2018.05.013

Hake, R. R. (1998). "Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses." Am. J. Phys. 66 (1): 64–74. https://doi.org/10.1119/1 .18809.

Freeman, S., S. L. Eddy, M. McDonough, M. K. Smith, N. Okoroafor, H. Jordt, and M. P. Wenderoth. (2014). "Active learning increases student performance in science, engineering, and mathematics." Proc. Nat. Acad. Sci. USA 111 (23): 8410–8415. https://doi.org/10.1073/pnas .1319030111.

VAHID JAVIDROOZI, CHRIS MAGUIRE, GERALD FELDMAN y NASSIR IBRAHIM (2024). "Facilitating organisational decision-making process through LEGO® SERIOUS PLAY® method" en International Journal of Management and Decision Making (2024, vol. 23, n. 6. 127-140)

JOCHEN TEIZER, OLGA GOLOVINA, STEPHAN EMBERS y MARIO WOLF, (2020) "A Serious Gaming Approach to Integrate BIM, IoT, and Lean Construction in Construction Education" en Construction Research Congress 2020: Project Management and Controls, Materials, and Contracts pp. 21-30. doi:10.1061/9780784482889.003

D. López-fernández, A. Gordillo, F. Ortega, A. Yagüe and E. Tovar, "LEGO® Serious Play in Software Engineering Education," in IEEE Access, vol. 9, pp. 103120-103131, 2021, doi: 10.1109/ACCESS.2021.3095552.

Victor, B., Roos, J., & Rasmussen, R. (2002). U.S. Patent Application No. 09/772,810.

Piaget, J. (1954). The construction of reality in the child. Basic Books. https://doi.org/10.1037/11168-000

Primus, D. J., & Sonnenburg, S. (2018). Flow experience in design thinking and practical synergies with lego serious Play. Creativity Research Journal, 30(1), 104–112. https://doi.org/10.1080/10400419.2018.1411574

Springer, L., M. Stanne, and S. Donovan. 1999. "Effects of small-group learning on undergraduates in science, mathematics, engineering and technology: A meta-analysis." Rev. Educ. Res. 69 (1): 21–51. https://doi .org/10.3102/00346543069001021

Stephanie Wheeler, Jonathan Passmore, Richard Gold (2020). All to play for: LEGO® SERIOUS PLAY® and its impact on team cohesion, collaboration and psychological safety in organisational settings using a coaching approach. Journal of Work-Applied Management. Vol. 12, issue 2. Emerald Insight. ISSN: 2205-2062

Kriszan, A., & Nienaber, B. (2024). Researching Playfully? Assessing the applicability of LEGO® Serious Play® for researching vulnerable groups. Societies, 14(2), 15. https://doi.org/10.3390/soc14020015

Wankat, P. C., & Oreovicz, F. S. (2015). Teaching Engineering, second edition. Purdue University Press.

Cullum, P. (2019). Play as a technique for history in higher education. University of Huddersfield. Retrieved from https://pure.hud.ac.uk/en/publications/play-as-a-technique-for-history-in-higher-education.

Kawahara, D. (2019, January 14). Constructive play: LEGO for learning in history, heritage and beyond. University of Lincoln. Retrieved from https://history.lincoln.ac.uk/2019/01/14/constructive-play-lego-for-learning-in-history-heritage-and-beyond

