

TOWARDS AN IMMERSIVE VR AND GAMIFICATED EDUCATIONAL MODEL FOR CONSTRUCTION COURSES. A VIEW ON THE BENEFITS AND DRAWBACKS

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Abstract

Virtual Reality and Gamification are gradually gaining more and more influential ground as methodological tools in a huge variety of teaching approaches, which can either replace or strengthen the conventional educational models in a lot of different sectors of education. A part of such digital approaches can also be found in the training of engineers like architect or civil engineers, specifically for the courses related to the Construction. In these methodologies a direct and remote virtual familiarization with building construction sites or even a gamified experience of them is used by educators. The incorporation of the above different approaches is applied independently on the basis of forming a multi-channel teaching framework. Furthermore, the successful attempts and proposals of their independent implementations have also led to their joint use as a combination of educational methodologies in the learning experience of engineers and students of engineering science. More specifically, it has to do with the simultaneous use of VR full immersions into building construction site environments, which are enriched with specific features of Gamification for the educational experience with the construction site processes within them. The use of such models requires an initial understanding of the theoretical background of the benefits and the drawbacks accordingly. The selected methodology of this study concerns a review and analysis on relative findings from theoretical and empirical studies, through the years. This resulted in specific conclusions about the different types and categories of the reported benefits and drawbacks. As well as specific guidelines that can be used for a framework of their safe and efficient application, as optimization and correction but also through limitations where necessary. The clarification of the two sides led also to some suggestions for future research regarding the adoption of this framework by educators of engineering science.

Key words: *virtual construction site, gamified construction site, immersive learning*

Introduction

At present, modern teaching scenarios are becoming more and more inclusive regarding the implementation of VR (Virtual Reality) and Gamification practices, as learning tools, in terms of reforming, facilitating and strengthening the existing conventional teaching models. According to Macpherson & Keppell (1998) VR is produced as a mind status on behalf of an individual that can -to a range of degrees- absorb their awareness similarly to the manner of actually being in a real environment, and according to Deterding et al. (2011) Gamification describes the “use of game design elements in non-game contexts” (p. 10). So, it concerns a more subtle use of these elements and as Kapp (2013) explained via examples it is like taking a functional piece from an entity. Both their success in different areas and their technical, conceptual familiarity have led to the expansion of their independent utilizations in their collaborative co-existence, on the same mixed educational models. Therefore, the product of this mutually beneficial synergy is the utilization of Gamified Virtual Learning Environments and in particular of the Immersive ones.

Generally, a Virtual Environment is defined as an “interactive, virtual image displays enhanced by special processing and by nonvisual display modalities, such as auditory and haptic, to convince users that they are immersed in a synthetic space” and has the role of a communication medium for interaction between a human and a machine (Ellis, 1991 as cited in Ellis, 1994, p. 17). The Immersive ones are those where a user can experience immersion which as Agrawal et al. (2020) explained is about a deep mental engagement of an individual that contributes to a cognitive shift in their attention having to do with the disassociation of their awareness from the physical world. The further gamified modification of such environments concerns an additional layer of integrated elements and principles of the Gamification typology which can be better explained through the framework of MDA (Mechanics, Dynamics and Aesthetics) where Mechanics refer to the traits used for the representation of data and algorithms (e.g. controls) that are at the user’s disposal. Dynamics are elements like a time constraint that have to do with how Mechanics affect the inputs of the players and each other’s outputs. Aesthetics like the common sense of challenge is related to the desired feelings of the player, while they are interacting with the system of the game (Hunicke et al., 2004).

In these immersive virtual spaces, the user can be surrounded by 360-degree content (graphical or captured via camera), using relevant hardware and software, which mainly contribute to the telepresence and interactivity inside them. For instance, a Head-mounted Display can track their head motions so as to be able to have several viewpoints in the altered space or by using joysticks the individual can point, select and manipulate the integrated virtual objects and the game-objects as well. The more advanced the special equipment is, the more precise the navigation and the overall simulation mode can be. Consequently, in the case of the successful accomplishment of such practises in the context of pedagogy, students feel like they have been placed in an altered learning environment rather than the physical one (e.g. classroom, lab). These immaterial learning spaces are offered to students serving as more engageable and enjoyable practical simulations, which can be significantly more advantageous in terms of usability and learning efficiency.

In that direction, related plots have been studied and implemented in the educational field of Engineering Studies, with significant research interest in the sub-class of teaching courses related to building constructions in related schools and departments as most commonly the Architectural and Civil Engineering ones. One representative example is the immersion of students in virtual building structures and construction sites (authentic or not) of projects in the development process. By being tele-present in each one of the above virtual spaces, students can be facilitated to be remotely, timely, consecutively etc. in touch with the

theoretical as well as the practical principles of the construction process, which were introduced in a conventional manner in the physical educational settings.

Such innovative educational methodologies, when integrated into the field of engineering pedagogy can potentially enhance the learning experience in a more realistic way, as opposed to the various difficulties and the educational weaknesses that occur in the cases of the actual visits and tours in real building sites. More specifically, the joint educational utilization of Virtual Reality and Gamification in the relevant academic subjects in engineering pedagogy can provide an ILE (Immersive Learning Environment) that is based in a building construction site and presents the embedded constructional actions, processes, etc. as well as its general characteristic ambience in a more dynamic version. Furthermore, after the incorporation of several elements and practices of a Gamification-centered approach, such an environment can be even more enhanced in terms of its potential to provide additional benefits, that reinforce the immersive visit, like fun, motivation and engagement among others. The elements of Gamification can be layered and be represented by graphical icons which are well-acquainted throughout a plethora of video-game playfields in virtual worlds.

The resulting mix-approached environments can be added as subject materials in specific educational settings related to building constructions, where the learner can navigate and interact with building sites and their included objects, factors etc. So, in addition to their immersion, mini quizzes can also be found that test their prior acquired theoretical knowledge, they can gain or lose points according to their educational performance, they can level up after succeeding, act in a specified time frame and take advantage of an abundance of other features that can be incorporated. The above-mentioned methodological synergy placed in the frame of construction education leads to outcomes that derive from their joint practices, which provide different classes of benefits, but also drawbacks.

As follows, the specific research will provide a cognitive basis regarding the former and the latter in accordance with the mixed methodological framework under examination, based on its utilization for the Construction Courses and more specifically its focused uses on the academic engineering studies. That clarification based on relative research findings will moreover lead to a collection of guidelines regarding the secure suggestion of them as educational tools at both educators and students' disposal. Additionally, further research will be outlined as a complementary supportive approach for the most successful adoption of such an educational framework of use possible.

Independent and synergistic Gamified and Immersive VR Learning related approaches

Through the years researchers and educators of the Construction Education field have either proposed or applied independently and collaboratively the use of VR practices and the ones that derive from Game Design. Regarding the former, tools from its spectrum as Kim & Leathem (2018) noted covers a range from the low-level immersion, presence and telepresence in desktop systems to the high-level ones when an HMD (Head-mounted Display) is used. More analytically, the inferior ones refer to the context of NIVR (Non-Immersive VR), also called Desktop VR, which is when a virtual environment is displayed and provided for interactions in one or more simpler monitors like the computer screen ones (Mandal, 2013). A Virtual Environment describes a space that is produced via a computer and within it there are objects which are displayed on a device, and it is offered for interactions in real-time through technological interface, in contrast to their actual existence (Flavián et al., 2019). More specifically NIVR has two sub-classes which are the 2D-3DNI, with the first being based in monocular view and the second in stereo-presentation view through anaglyphic glasses (Kozhevnikov & Dhond, 2012). On the other hand, IVR is mostly based on the use of wearables like Head-mounted display (commonly known as VR headsets) for achieving visual

isolation as well as sound independence, data-gloves and hand-controls as joysticks for tactile, haptic relationships with virtual elements with the aim of re-creating the virtual equivalents of the real moves of the user in the virtual environment.

In the context of virtualizing the educational field of Construction Education, over the last decades different VR tools have been adopted. In general, in addressing design and construction issues, VR has been applied to issues such as: 1) early design decision-making and design processes, construction education, safety education, facility management, conflict detection, project coordination, design education, urban planning and project design (Alizadehsalehi et al., 2019). More specifically the categories of educational uses of VR in constructional education cover the: 1) architectural visualization and design education, 2) training for construction safety, 3) safe equipment and operational task training, 4) structural analysis (Wang et al., 2018).

From the NIVR to the high-level IVR the overall aim is to provide students of Engineering Sciences with realistic simulations of spaces representing building structures or even more complex construction sites as well as their workplace ambience from the inclusion of their internal procedures. As these methods are heavily dependent on each VR era technological capabilities per its historical phases, the earliest attempts were based in desktop systems. The more timelessness of the CAD modelling for construction plans and models which even today still replaces a significant part of the traditional drawing procedure in the related academic studios. Such early CAD based VR applications showcased in Penn State University by Messner et al. (2003) where students of Architectural Engineering Program tested a 4D CAD model, meaning 3D design plus time via two experiments, reviewed and identified construction schedule conflicts about the project of an office building. Later, in the Virginia Polytechnic Institute and State University Setareh et al. (2005) introduced the VSAPD system including an immersive edition with an HMD, a tracked tablet and pen, to manipulate objects and navigate around and above the building structure among others. These examples provide a better sense of interaction which according to Mihelj et al. (2014) can be generally categorized into manipulation, navigation and communication and overall as Steuer (1992) explains has to do with how the user can modify an environment which is mediated in real time, in terms of its form and content.

The above IVR examples served as pioneering to the earlier more advanced attempts in which there is a more authentic simulation both related to the representation techniques and the immersive ones as well. So, through the years more sophisticated cases were showcased and utilized in the related pedagogical field, using simple graphical or data-rich BIM models of building structures but even graphical or authentic (based on 360-degree captures) construction sites. These more realistic approaches included crew members sharing task-related information or more practically operating while wearing special equipment (e.g. safety helmets), using necessary tools (e.g. drills) or even heavy machinery (e.g. bulldozers). The more dynamic depiction of the workplace rather than the ones presenting only the building structure can lead to the better immersion in the environment in question, in terms of a work-related simulation. As according to Agrawal et al. (2020) immersion is associated with immersive potential and immersive tendency, where the first refers to its system or its content ability to arouse it and the second refers to the individual's predisposition to become immersed. So, by displaying a full construction site, educators can trick the students' sensory boundaries and guide them towards the ultimate feeling of being fully engaged in these educational spaces as they are really inside them.

General benefits of VR and Gamification in education

The tools and methods of VR and Gamification when integrated in educational scenarios have been proved beneficial in how pieces of knowledge -even taken from the most abstract and difficult topics- are presented, delivered and absorbed, facilitating the job for students and educators as well. Their well-established incorporation in modern education is shown through an abundance of relative applications at different educational levels (e.g. schools, universities) based on purposeful learning scenarios. Their partial or total uses can either accompany or replace the more recognized systems of the conventional way of teaching and provide innovative practices (e.g. framework of use) and materials (e.g. special VR devices) at the disposal of educators. Both of them are related to different beneficial learning outcomes that derive from their justified, organized and theory-based utilization when that is necessary (as a solution to a well-known gap) or simply better. For instance, in cases where the traditional pedagogical ways appear to be unable to cover the lack of providing an effective simulation space for practical familiarization with previously given (e.g. in lectures) theoretical topics. An overview of their general educational positive effects is needed prior to the examination of the targeted ones in Construction Education and moreover for the justification of the value for their joint uses in mixed scenarios as a manner to increase the profitable outcomes.

A widely accepted summary of the characteristics of VR, which justify it as a means in the educational process, was presented very early by Kalawsky (1996), that included possibilities as: 1) experiencing both places and situations that are not possible, 2) experiencing events that are impossible due to real time limitations, 3) scale changing for a better insight given, 4) controlling physics towards a better understanding, 5) form real or abstract spaces as basis for learning, 6) manipulating of conceptual representation for better comprehension and last 7) motivating.

Since the above-mentioned advantageous factors support students' position in the VR learning process it is worth mentioning the ones that enhance educators' job as a guide to such methodology. Kalawsky (1996) highlights distinct possibilities on behalf of educators as: 1) flexibility, 2) the ease to upgrade to different applications, 3) feeling of presence, 4) high interaction, 5) easier 3D interaction and display, 6) realistic scale in relative fields, 7) safety that exceeds limitations, 8) safety that exceeds dangers, 9) ability to observe internal things, 10) interaction and 11) ability to provide teaching of complex cases.

These beneficial factors are in general related to the VR educational systems like the desktop ones and not specifically to the ones where immersion of students occurs. Therefore, it is worth noting the latter with more focused specific points presented by Häfner (2020) that emphasized in immersive learning systems, linked to the enhancement of motional coordination, physical skills, motivation and engagement, focus and concentration, fostering of skills like communication, collaboration, problem-solving, the saving of time and costs, the adaptation to special needs and the usage of different didactic approaches.

Rather than the non-specific advantageous effects of VR in education, the general ones associated with Gamification should also be mentioned for outlining the basis of their educational rationale for use. Mirzaie Feiz Abadi et al. (2022) presented the matter of the boost of learners' engagement by the aspect of having fun, the boost of motivation via a feeling of achievement, challenges that ensure maximized potential, instant feedback, individual pace for learning, social interaction, problem solving, optimized hand-eye coordination.

The presented features as laying the cognitive foundations for the justification of the two practices potential positive outcomes -of course in relation to a responsible approach on behalf of the involved educators-, should not be seen as isolated from the drawbacks that may appear, which are going to be introduced as follows.

General drawbacks of VR and Gamification in education

Having established a better understanding of the positive side of using VR and Gamification in education generally, it is worth mentioning distinct native or potential drawbacks that may appear, and that can possibly threaten the right flow of the learning process. The specific initial elucidation will serve as a valuable preparatory background for the strengthening of these new methodologies in advance. The specific disadvantages are strongly needed for the introductory clarification, as the specific tools in the field of pedagogy have only been widely known for the last decades, in contrast to other well established traditional methodologies that have been proved timeless. In addition, their applications in several educational settings, topics, cultural environments, countries etc. have not been tested widely and indeed throughout a large chronological frame. Such an introductory background is seriously necessary for posing some relative limitations to the new methods independently or collaboratively with the traditional teaching tactics, as a means to fill some of their gaps. Likewise, in the case of the general educational beneficial effects, the following presentation stands as a prior approach to the examination of the more focused ones in Construction Education and moreover for the defense of their suggested collaborative utilization in mixed strategies, by preventing both sides of the potentially derived negative outcomes.

A good hierarchized synopsis of the limitations of VR, which should be concerned to address its secure incorporation in the educational process, was presented by Kavanagh et al. (2017) who noted matters such as: 1) usability of the software, 2) lack of engagement, 3) cost, 4) inaccuracies regarding recognizing 5) non sufficiency in terms of authenticity, 6) lack of enough effectiveness, 7) hardware usability about the input, 8) need for training, 9) lack of feedback, 10) motion sickness and other issues.

Like in the case of the previous approach (for the advantages) the pre-mentioned disadvantages can be regarded generalized for the various VR tools and methods. So more focused points listed by Häfner (2020) about Immersive VR included the technical drawbacks related to presence, immersion and acceptance such as lags and discomfort, distraction from the learning situation, physical negative issues like motion sickness, sanitary issues, emotional damage, lack of communication due to wearables and miscellaneous issues.

As far as the negative aspects of the added Gamification practices are concerned, a very representative approach was made by Mirzaie Feiz Abadi et al. (2022) who demonstrated significant factors as that it is expensive to be developed, it does not have timeless value but it diminishes over time, games that are only poor masked quizzes, pointsification, competition, assessment challenges, retaining information issues, cheating, frustration, regulatory and legal issues, effect assessment.

Targeted benefits and drawbacks upon the Immersive VR and Gamified educational experiences of building construction sites

The above pros and cons serve as cognitive grounds for the following clarification of the most targeted benefits regarding their inclusion in every educational domain where the former can take a different form and gravity linked to the domain's nature. More specifically, in this section the above presented general benefits and drawbacks of VR and Gamification will be targeted in relation to their use in experiencing gamified and virtual construction sites in a state of full immersion by students of Engineering Sciences. The process of tailoring the pre-mentioned general benefits to the special context under examination will be supported by relative findings in literature and personal observations, that support each one of the selected and adjusted points.

Starting with VR, regarding the focused benefits the authors of this paper specialized some of the general ones which they suggested as more relevant to the pre-defined educational use and these concern the:

- 1) Possibility of experiencing a construction site and its related procedures which would not be possible in any physical manner. As Kostopoulos (2022) argued traditional educational settings are dissociated by the practical application of the building process in the real world, therefore he proposed a scenario-solution of Practice-based Learning methodology for the Building Technology Education upon a design-build project in real time. Another problem related to location-related limitations is the objective negative issue of not being able to find all the construction structures available in the area of the university institution (Zhang et al., 2017). But even in the case where location is not a problem, there may be other spatial and temporal constraints. For example, Kim & Leathem (2018) mentioned time conflict with other classes, large class for site's size, limited university support or resources. Another experience that would not be possible is the one of the presentations of several safety related problems for the enhancement of students' situational awareness. As Gamberini (2021) noted nowadays, VR implementations can provide safe recreation of dangerous issues for which there is no ease to be experienced in the real world. One more significant factor that is virtually possible is the one pointed by Ku & Mahabaleshwarkar (2011) and it has to do with real-time communication as well as interaction between users that are geographically dispersed.
- 2) Opportunity to experience constructional events in non-real time that in an authentic visit in a site would be too short or too long. A problem related to the time factor is the inability to find an available construction site, where construction work is carried out with the relevant knowledge introduced in the course (Zhang et al., 2017), so the available construction sites may not be in a state that is linked to the current lecture topic. Also, the use of animations that are time-based on 4D models can project the progress in a constructional project through time, providing better comprehension that for instance are seen in 2D drawings or charts (Kunz & Fischer, 2012). Moreover, time lapse representations can be added in the virtual space showing the evolution of the construction process from start to end, that typically would require months or years of unstoppable observation. In this way, Messner et al. (2003) showcased a virtual system of identifying construction schedule conflicts (e.g. sequencing rules) through time in the undergraduate Architectural Engineering Program of Penn State University. But rather than the 4D animated construction sequence in planned time Ibrahim et al. (2008) argue about the necessity of an as-built process documentation which can be addressed with the use of time-lapse based photographic movies attached to a VR model.
- 3) Provided options to make changes in the scale of the overall construction site or its integrated objects that provide more significant insight. Also, in a three-dimensional virtual environment the users can have any point of view, even the one of disconnected and reconnected elements again and again (Thabet, 2002). The specific treatment can be easily done in a BIM model, but not without limitations. As Huang (2021) argues Extended reality (XR) -including VR- offers solutions to the BIM weakness, where even though the user has the ability to walk into a project that used to happen on a non-human scale. Whereas in an immersive experience a student can feel the environment surrounding them on a realistic scale, like actually being inside it.
- 4) Ability to control the underlying physics in a construction related situation for a better understanding. From that perspective students can easily modify virtual objects representing structural elements, like extruding them, exploding them or seeing-

through them. For instance, in the case-study of the construction of a wall in Sampaio (2004) research the presentation of that wall could show an explosion of the vertical panels.

- 5) Choice to use a real or an abstract construction site for the enhancement of the learning process. As an example, Shojaei (2021), Kim & Leathem (2018) used panoramic captures from real construction sites to use as a basis for the virtual environments. Nowadays the specific tactic is easy due to the advancement of capturing devices. Huang (2021) presented two ways, the low-cost method of unifying photos with a mobile phone to produce a panoramic view as well as with a 360-degree camera to form spaces in which users can be immersed. On the contrary, there is also the ability to use an abstract environment that does not exist at present, like constructions in past historical eras, in which students could obtain valuable construction details about building techniques of the past.
- 6) Capacity to experience the construction site in a safe way. A way that could inform students about hazards and accidents, without risk. The innate nature of remote visualization and experience in VR leads to the risk-free provision and examination of constructional tasks that are typically dangerous. Li et al. (2018) had earlier proceeded to categorize safety reinforcement mechanisms in related settings as the: 1) work environment containing hazards that users can experience virtually, 2) work behavior in terms of learning about safety equipment, 3) workflow that if done incorrectly can lead to problematic issues, 4) high-risk equipment use. Indeed, the necessity of a virtual safety-related preparatory familiarization can be highlighted by Spišáková et al. (2020) who in their research on increasing safety on construction sites presented a percentage categorization of the most common accidents: 1) falls (33.5%), 2) being struck by an object (11.1%), 3) electric shock (8.5%), 4) entrapment (5.5%). While in addition they noted a categorization of the risk scenarios of construction sites from low (e.g. someone could trip), low to medium (e.g. falling from a ladder), medium (e.g. electrocution from cables), medium to high (e.g. being hit by a heavy vehicle) and finally high (e.g. falling from a high point).

Concerning the same approach for the targeted benefits according to the gamified approach of these virtual construction sites, the authors presented as more relevant the:

- 1) Problem solving-based visit in the construction site. A practice that is in the direction of learning by doing and therefore students can gain practical knowledge and hands-on experience in a virtual manner.
- 2) Training of the hand-eye coordination upon high-risk construction activities which contributes to the overall site's inspection. In that direction, students can start to increase their situational awareness towards a construction site and prevent themselves and others from facing dangerous situations.

On the other hand, the previous general negative aspects of VR still apply but in a different way in the applications in the educational context under examination. The tailored ones for this category are the:

- 1) Lack of efficient realism of the construction site. Non-efficient realism can trouble the tendency and the process of becoming immersed and that fact may create a cognitive gap between the simulated and the real, which may lead to the non-development of situational awareness valuable in the real world's dangerous scenarios. Also, the students should be able to sense the materials (textures) which is not possible in relation to their virtual equivalents.
- 2) The unsatisfactory manipulation of the construction elements due to input hardware usability problems. Problems with the supportive devices which may lead to low level

interactions with the construction elements and are necessary for obtaining a full understanding of the environment in question.

- 3) The limited manipulation of the construction elements due to recognition of inaccuracies. For example, gestural recognition and object manipulation of structural elements may not be effective. In addition, there might be a problematic type of walking through the construction site, which poses a serious technical malfunction in the overall tour in the site. Lucas (2018) refers to movement lags which are likely to happen when simulation is very detailed for the processing power of HMD. In addition, there may appear a lack of efficient kinesthetic simulation which affects the high-risk equipment operation (Li et al., 2018).
- 4) The lack of immediate safety-related awareness due to lack of educators' feedback. More specifically, negative feedback from educators or leading engineers on the real construction sites towards their safety-related mistakes. On the other hand, positive feedback associated with safe-related correct actions to boost their confidence. These two types of feedback on behalf of the educator are not so easy to be given in a self-paced and isolated experience like immersion.

According to Gamification practice, the chosen targeted negative outcomes from its supplemental use in the experience of the virtual construction sites in question that are highlighted in this research are:

- 1) The marginalization of the significance of the severity risk factors by the fun and the playful character as the integrate game-oriented features may not be purposefully placed in terms of an overall didactic focus.
- 2) The undermining of the team spirit in constructional operations due to the emphasis on the competition-based aspects. Soetanto et al. (2012) highlighted the necessity of introducing aspects of collaboration at a multidisciplinary working level, meaning between building design teams in the stage of Construction Education curricula, for their preparation of themselves as built professionals. Gamification's innate nature of competitiveness may threaten the general team spirit which is an essential mindset in the construction site workplace.

Guidelines for optimizations and limitations

Regarding the above tailored benefits and drawbacks potentially found in the specific methodological synergistic tool, the authors continued with providing particular guidelines for optimizing the benefits and constraining part of the drawbacks. These are listed as categories that each one may cover different areas of the issues that were posed earlier, such as the:

- 1) Mixed-approach of modeling the immersive virtual construction site involving different spatial versions in relation to the various time-dimensions of the project building phases. Meaning that it would be fertilized that the case-study building site given illustrates the evolution of its different spatial versions through time (e.g. with timelapse). Therefore, the student can experience -in a relatively short period of time- changes that otherwise would cost them months or even years. On the other hand, the aspect of involving time could be used for slowing down or restarting the display of specific procedures that realistically could not be undone and repeated.
- 2) Use of Gamification aspects to provide immediate feedback on safety-related factors, with serious game-penalties and loss of points to provoke gradual behavioristic changes upon these matters.
- 3) Use of authentic virtual environments of constructions sites from 360-degree captures of actual sites that involve real people (e.g. crew members) on hands on experiences,

but also communicating with each other in a collaborative way, reflecting both their group successes and failures for the desired authenticity.

- 4) Offering the exact number of interactions in the construction site that are necessary for less negative technical performances as the goal is not to provide a full actively engageable environment like the ones of the Gaming Industry, but an educational one. Both the developers and users of such learning spaces should consider them as entities of simulations for educational visits in construction sites, where by protocol students are not allowed to manipulate random elements and tools.
- 5) Providing real-time feedback from the educator to the student while they are immersed in the VR constructional environment. This act can be accomplished via several techniques and is somewhat opposed to the self-paced nature of Immersive Virtual Experience as it could make students feel partially re-attached to the real educational setting. However, it could provide a subtle connection with the educator's feedback concerning a subtle control of the experience where necessary.
- 6) Offering subtle design elements for the synergy with Gamification, where necessary for didactic purposes, that do not overlay the overall purposefully design of the teaching scenario by a generous infusion of fun aspects.
- 7) Use of team-based teaching scenarios as a basis for the presented methodology that enable the collaborative spirit and a simulation of interacting as a crew group. For instance, immersive VR construction site of multi-presence of students in groups should be considered.

Conclusions

The presented research was about exploring the clarification of the different sides of the Immersive VR and Gamified education methodology for the construction courses related to an innovative way of being in a virtual construction site. As was explained, the two different practices can be used in synergistical scenarios for learning in virtual building construction sites in a mixed-model that can enhance the student's experience with additional game-oriented tools that support the overall didactic aim. By presenting the educational benefits and drawbacks independently for the two practices in general, an initial cognitive background of understanding towards their integration in the field of pedagogy was outlined. Based on these two sides, the authors proceeded with a tailored approach so as to illustrate their targeted occurrence in the educational setting under examination. The approach in question was based on relative findings with which their special impact on the mentioned focused area of use was drawn. Finally, specific points as lines of guidance for optimizing or putting limitations where necessary were listed and described. Each of these suggestions when applied correctly can cover more than one of the concerns that were initially highlighted. The listing points in question can be utilized as a valuable tool for the creation of an efficient and secure framework of use of the presented innovative teaching and learning tactics. Finally, supplemental research work is proposed towards a model based on the above suggestions that will be tested via primary level research in students of the field of Engineering Sciences. This following research will address both the user's experience on behalf of the students, but also its use from the perspective of the relevant professional educators. Such a study should involve relative experiments with the use of HMD devices in order to achieve the desired outcomes.

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