Efficacy of Gamification on Introductory Architectural Education: A Literature Review

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Due to their recent popularity and success in fields such as engineering and business, gamification and by extension game design principles demonstrate the ability to teach complex, multi-disciplinary skills in an engaging, entertaining, and effective way. Architectural education especially introductory architectural education is a foundational and fundamental part of a budding architecture student's career and oftentimes requires the understanding of dynamic systems, spatial reasoning, and experiential learning. The paper posits that gamification and game design principles can utilize certain components such as augmented reality, narrative design, and fun in order to create tools, gamify existing curriculum, and increase retention, engagement, and mastery of the difficult high-tech skillsets required of introductory architects. The paper focuses on reviewing and systematically analyzing research on gamification in education. In particular, it focuses on systematically reviewing and analyzing data from multiple relevant case studies chosen based on the application of technology such as augmented reality, the integration of game design, and the feasibility of gamification in educational environments. This data is examined based on feasibility, accessibility, and effects on information retention and the findings are outlined in a comparative table of methods, tools, and technologies organized based on their suitability. Ultimately, the paper aims to establish a framework for gamifying introductory modules in architectural education and hopes to create a future architectural augmented reality game meant to utilize gamification to help new architectural students.

Keywords: *gamification, game design, architectural education, educational games, retention, learning*

INTRODUCTION

Introductory architectural education requires a complex understanding of not just traditional academic concepts but also an ever-growing, high-tech skillset paired with an understanding of dynamic systems, spatial reasoning, and experiential learning. Within architectural education, there exists an ongoing debate on which digital technologies and strategies should be implemented and which analogue methods should be preserved especially as new methods and tools such as augmented reality and virtual design become more accessible. Though no perfect widespread model exists for teaching introductory architecture, the existing pedagogical literature synthesized and organized the foundational concepts and evaluation frameworks necessary to gamify educational modules. Gamification concepts such as point value systems, social networking, and game design have been utilized in educational environments with positive results though never in introductory architecture. Additional variables such as game literacy and player experience must be considered but with proper implementation, gamification and game technology could allow introductory architecture students to retain, understand, and engage with the complex, multi-dimensional skill sets and knowledge are necessary to begin the architectural journey. The purpose of this literature review is to examine the literature, innovations, and technological fields related to gamification and education for feasibility and applicability in introductory architectural education.

Although gamified principles, architecture, and education have been explored and applied separately, these concepts have not yet been fully integrated together, especially with the aim of studying the effects on retention and understanding of architectural knowledge. There exist case studies examining the effects of gamification and game design principles on other principles such as computer science and engineering but no such application exists when it comes to teaching the introductory aspects of architecture. The research aims to understand the effects of game design and gamification on education by systematically analyzing and comparatively reviewing gamification methods, tools and techniques in architectural education. In particular, we are examining related research projects and their game design concepts, their effects on participants as well as understanding methods of optimizing and reducing

potentially negative variables such as lack of engagement. The paper investigates both the existing body of literature as well as technologies such as augmented reality and virtual reality in an attempt to answer the following research questions:

- Which are the available teaching methodologies, tools and techniques suitable to gamify architectural education?
- Which of these techniques are suitable for the gamification of introductory undergraduate architectural education modules?

Figure 1: Review Methodology

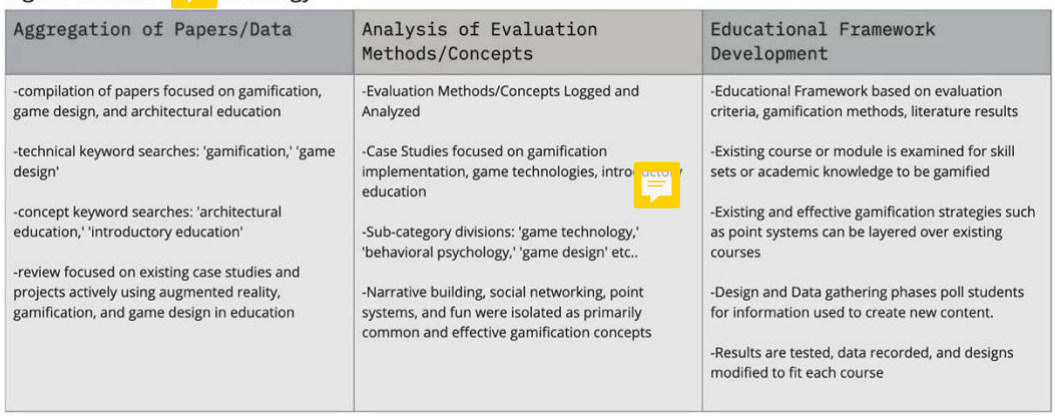

Figure 1: Review Methodology Phases

REVIEW METHODOLOGY

The systematic review consists of three phases (Figure 1), including 1) aggregation of relevant papers and data, 2) analysis of evaluation methods and concepts, 3) graphically outlining and utilizing results to begin the design and development of an educational framework meant to gamify introductory architectural classes.

Phase One consists of utilizing online databases (IEEE Explore, Google Scholar, CumIn CAD (Cumulative Index about publications in Computer Aided Architectural Design) to compile pre-existing projects and papers centred around gamification, game design, and architectural education. Technical keywords such as 'gamification' and 'game design' are searched in combination with concept keywords such as 'architectural education' and 'introductory education' inorder to identify projects in which gamification, game design, and game technologies were implemented in educational environments. Due to the relatively nascent nature of the technology and the field, the research identified 245 academic publications which were then systematically reviewed and compiled into a final applicable list of 10 academic papers,

case studies, and preliminary implementations of gamification in assorted educational environments as well as the two comprehensive books 'The Gameful World: Approaches, Issues, and Applications' and 'Rethinking Gamification.'

Phase two involves the isolation of useful and relevant gamification and evaluation systems with a focus on papers, data, and past experiments studying the effects on retention and understanding of educational concepts. Though the application of gamification and game design on architecture specifically remains sparse, the 245 publication results are individually reviewed with an emphasis on several sub-categories involving tools, methods, and evaluation systems with further keyword sorting based on 'educational evaluation systems', 'gamification in educational environments', 'educational psychology', and ' game technology implemented in educational environments'. Special attention is paid to well-documented case studies with quantifiable data in regards to the specific usage of gamification/game design in introductory educational environments with chosen results reflecting similar STEM-related fields of computer science and engineering. All publications and case studies are further analyzed based on efficacy with an eye on results reflecting greater retention, understanding, and participation in class material after the implementation of gamified concepts. Criticism of gamification as well as variables and concerns are also analyzed and incorporated in order to produce the most accurate framework. Phase three takes these results and uses these evaluations to begin the speculative design of an educational framework designed to test the findings presented in the review.

ANALYSIS OF PAPERS

In 'Digital architecture as a challenge for design pedagogy: theory, knowledge, models, and medium', Oxman (2008) details

the way in which the influence of digital design has necessitated the re-examination of existing pedagogy and the creation of new educational frameworks. Oxman discusses how architectural design education has been influenced most heavily in the past few decades by visual reasoning-focused pedagogy of design characterized by reflection and supported by representational processes. In recent years, the advent of digital technologies has influenced new theories of form generation and allowed for unprecedented generative and performative design methods, integrating theory and modelling in unprecedented ways. Even core design principles such as precedent-based design, representation, and typology have begun undergoing progression and change as new concepts of performance-based design, generational models, and animation have emerged to replace them. The scale of these changes in the architectural field demands new requisite knowledge and skills centred around an architectural and design pedagogy that accommodates this modified knowledge base.

Oxman elaborates on three distinct models (formation, generative, and performance-based) that digital design and technology have transformed.

In formation models, digital design theory has evolved the traditional concept of form into the formation with new design tools allowing creators to depart from graphical and syntactic representations of form. In generative models, computational mechanisms have allowed for simulations that can mimic mutation, reproduction, and growth in architecture, turning static representations into adaptable models. In performance-based models, these same digital tools and simulations also allow for analysis and evaluation of the performance of designs before construction, directly modifying the design process.

In addition to pedagogical changes, new challenges arise in regard to design problems that gamification may hold answers to remedying. Design problems are often not apparent and must be discovered with no clear obstacle or goal, unlike traditional mathematical problems or brain-teasers. (Oxman) Gamification and the generative simulations of game technology allow designers to utilize multiple iterations of virtual design to play test and discover persistent design problems far more efficiently and effectively than traditional methods (Walz) Design problems can be multi-dimensional and highly interactive but existing techniques only provide predictive methods and evaluation tools. Game design and digital technology allow designers to confront these design problems in a virtual space with a high degree of interactivity and dimensionality not found in traditional tools. Design problems often suffer from limiting factors of time, money, and information. Virtual simulations can allow designers to explore and problem solves in an infinite, consequence-free environment before bringing designs into the real world.

In ‘How Designers Think: The Design Process Demystified’, Lawson (1980) elaborates on the practical application of gamification to novel student expertise building by discussing a case study in which introductory design students working on a design project happened to switch their focus to building an igloo together outside after a snowstorm. In this spontaneous moment, the design students were able to design and create a project collectively due to the inspiration of play, working together to gamify the design process without prior examination. Lawson describes how the common archetype of an igloo shared by the students and the experience of gamified play allowed them to ‘immediately, and without any deliberation switched from the highly self-conscious and introspective mode of thinking encouraged by their project work to a natural unselfconscious action-based approach’.

In ‘A Critical View on Pedagogical Dimension of Introductory Design in Architectural Education’, Farivarsadr (2001) outlines how critical introductory architectural courses are, the skill sets and challenges that make up the instruction and learning process, as well as effective instructional models designed to teach the various technical and conceptual tools necessary to begin the path of becoming an architect. Introductory architectural education is critical as these first studio design courses are the initial introduction of students to not only foundational concepts but also a set of values, attitudes, and abilities crucial to their future success. These core abilities are identified as graphical aptitude, verbal/writing skills, research competency, critical thinking, foundational design skills, and an awareness of human diversity, tradition, and behaviours. However, Farivarsadr makes clear that there is no single, ideal method of teaching architecture that can be applied universally due to wide variability caused by the disparate policies of institutions, variable curriculum organization, different instructional belief systems, and the nature of students. An example is given of countries like Turkey where an authoritarian secondary education (in which students are discouraged from self-expression and free-form design) leads to first-year architectural students who oftentimes struggle with

research and creative work. Ledewitz (1985) summarizes three fundamental aspects of design education 1) the acquisition of new skills such as spatial understanding and visualization, 2) the comprehension of the language of architecture, and 3) utilizing these skills and language to solve problems and generate solutions architecturally. In introductory design classes, students learn these skill sets simultaneously and apply them daily in their design processes. Ledwitz introduces the day-to-day challenges that successful students must overcome such as independent thinking, problem-solving, critical analysis, as well as enjoyment of the material. These tasks serve as not only an evaluation framework but also highlight specific aspects that game design and gamification excel in such as concept enjoyment which is a crucial component of education often neglected in traditional systems.

GAMIFICATION

According to Nand (2019), gamification is by definition the incorporation of game-like elements in traditionally non-gaming environments with the objective of accomplishing a set goal such as altering user experience or incentivizing/de-incentivizing certain behaviour. One approach in the field of educational gamification has centred around the design of educational activities specifically tailored to engage and incentivize behaviour in the same way commercial games do. The characteristics and game design elements of commercial games can be thus integrated and embedded into educational tools with curriculum to enrich children's learning and further engage, motivate, and inspire players.

Salen (2003) discussed how she, as agame design author and executive director of the Institute of Play (a nonprofit focused on advancing game design and learning), launched Quest to Learn: a game-focused public middle school with a mission of innovating gamification techniques to transform traditional learning environments. Through a curriculum designed to teach traditional material in gamified modules, Quest to Learn was purposefully founded on principles of design and play with students and teachers taking on the role of designers in a pedagogical approach known as game-like learning. This consisted of exposing the students to complex problem spaces engineered to assist players in not just traditional learning but also in developing spatial reasoning, critical thinking, and value judgment. The content was fluid and adaptable to individual students and class needs based on evaluation criteria used by teachers who could design and re-design existing modules making the curriculum not static information to be memorized but an adaptable resource. Students were encouraged to engage in not only the material but also their surroundings in ways that focused on relevancy, engagement, and enjoyment. At the same time, the curriculum tackled all the required state learning standards with students learning traditional knowledge in gamified ways such as converting fractions in order to decipher code hidden in a library book or creating video tutorials for fictional game characters. Salen's example describes a pre-existing gamified educational system testing and teaching similar foundational concepts as those identified to be key in introductory architectural education (spatial understanding, critical thinking, etc..) with positive results. Though Salen's school struggled with issues of scale and was a school focused on younger students, it served as an example of how gamification techniques can be utilized to teach architecture-relevant foundational concepts in engaging, entertaining ways that also educate students on the more complex value and spatial based skills necessary in introductory design education.

Pienaru (2018) investigated games as community building and communication tools. The study utilized different types of student-driven games chosen based on their ability to bring people together and focused on creating networked consciousness through the act of the play, seeking to understand to what extent games can generate community-built intelligent environments. This was accomplished by examining how data/digital tools amplified personal and collective user experiences in an urban design environment. following gaming components of visualization, story-telling, and spatial geography

Pienaru (2018) tasked one group of students with mapping an urban environment with players inhabiting places of interest, sharing them on social media, and connecting with other individuals. Digital geographies are socially constructed spaces created by virtual infrastructure and physical geography. By creating a collective map of the city using this method, players were able to create an open-source digital guide that reflected aspects and themes not found in traditional representations. By connecting players in the real world at real locations with digital information and landmarks, the paper generated a higher level of visualization, a greater sense of spatial understanding, and digital social networks that connected physical locations, virtual assets, and players that inhabited both worlds.

The second group of students focused on utilizing storytelling as a methodology by playing City Planner: an urban design game in which players inhabited the role of an urban designer working to develop an ideal city. This initial version tasked players with learning urban design basics and creating habitable conditions through a narrative-focused game with each new challenge educating on another design principle. This iteration demonstrated an important, effective tool of game design which is the power of narrative to motivate, engage, and challenge players. In contrast to the more open-world first group, the second group was able to immerse themselves and roleplay in the story of the imaginary urban planner and learn urban design principles with an understanding of not only their spatial components but also their real-world value.

Through both these case studies, Pieranu (2018) demonstrated the potential of game methods to enable communication, create community-driven data flows, and handle even the complexities of urban design. The tools used were able to study the intricacies of urban design in a short time frame with little resources and minimal risk to the quality of life of individuals. Though the work was limited due to the time constraints of the participating university, it demonstrated how game design principles can create interfaces between people and their environments while providing a safe, efficient environment to understand spatially focused design scenarios.

Höhl (2019) explored the implementation of open-form teaching and social networking in game-based learning. Using blended learning, open space technology (OST), and gamification elements, Höhl (2019) designed a business game in which participants were grouped into interdisciplinary teams responsible for managing a 3D visualization task. Teams underwent concept,development, and implementation stages for their projects and were evaluated and then rewarded with play tokens that could be used for in-game benefits. These play tokens also were taken quantitatively into account in the final visualization project alongside specific qualitative design criteria. The game's social elements highlighted the importance of the networking component of gamification in the design process and the positive results it can create by incentivizing collaboration in environments in which players may be reluctant to work together. The social dynamics of the game were reported to improve teamwork, increase collaboration, and better social skills within inhomogeneous student groups when gamified elements such as the play tokens were implemented. In an improvement of traditional systems, the open form teaching, gamification technology, and social elements resulted in students reporting more enjoyment, greater interest, and increased

innovation and positive academic results from engaging with other participants. The communities and social networking fostered by games hold the potential to allow participants to better engage with and understand concepts by working collaboratively within the systems of a gamified module.

Holman, Aguilar, and Fishman (2013) demonstrated the positive potential of utilizing the gamification concept of point systems. Point systems are a gamified reward structure consisting of virtual points and items that can be earned through behaviour considered positive by an evaluation criterion. Behaviour can also be de-incentivized through the application of point deductions and penalties for disruptive or unfavourable behaviour. In their research, Holman, Aguilar, and Fishman (2013) discuss how from a practical resource-focused approach, the utilization of virtual rewards like points and cosmetics is not only less expensive than using a tangible reward but can also increase engagement and enjoyment while having the same effect on factors like productivity and retention. Variables such as individuals learning to abuse point-based systems for their benefit and disengagement with the material can occur. However, in lieu of grades, many experienced educators have begun gravitating towards experience point systems due to their role as user-focused growth models providing progress feedback, participant communication, and real-time tracking of retention and progress. Due to its low cost, adaptable nature, gamified point systems can be utilized in an introductory educational format in lieu of traditional grading models as a means of incentivizing better performance, tracking student results/ input, and adapting the existing curriculum.

Fuchs, Fizek, Ruffino, and Schrape, (2014) explored the concept of fun in educational environments. In 'Why Fun Matters: In Search of Emergent Playful Experiences', outlined the phenomenon of fun and the way gamified systems can adapt game mechanics to daily activities in order to create enjoyment and increase user engagement. Though difficult to define and influenced by a wide number of variables (user preference, user background, environment, etc) fun was discovered to be one of the most powerful motivators for player engagement. A product of interaction with the system itself, the authors outlined how playfulness was born from not just a

Figure 2
Gamification Components Summarized alongside their implementation, effects, and results

Gamification Concept	Implementation	Method Effects	Results	In text Citation
Virtual Reality	-open 3D environment combined with existing physical Space	-multi-dimensional understanding -local customs, attitudes, tradition learning along with academic concepts	-game literacy a requirement -nausea/discomfort from apparatus -resource and design limitations -model holds potential for interactive use	Bertruzzi (2018)
Social Networking/Community Building	-two student games: 1. digital mapping urban environment 2. narrative driven design game	-community building (players pool data/experiences) -digital geography (digital landmarks combined with real locations) -storytelling (narrative as incentive)	-narrative motivated/engaged players -spatial understanding and visualization improved -minimal risk/resources -Time constraints limited growth	Pieranu (2018)
Fun/Playfulness	-study and examination of origins of "playfulness" -defining "fun" and what elements cause it	-powerful motivator for player engagement -player interaction and meaningful gameplay must occur	-game rules + spontaneous player action = fun -requires level of game literacy to interact effectively	Fuchs, Mathias & Fizek, Sonia & Ruffino, Paolo & Schrape, Niklas. (2014).
Augmented Reality	-five virtual gamified urban scenarios with design challenges -video games and augmented/virtual reality used to teach -students modeled using software, completed tasks, analyzed results	-high spatial understanding -greater participation/enjoyment from students -technological mastery	-collaborative environment created through marriage of augmented, virtual, and gamification -complex visual skills and software/tech understanding gained	Redondo, Fonseca, Zapata et. al (2020

system of rules but also human engagement and culturally significant design. Playfulness can occur as both conditioned implemented rules as well as spontaneous player action. In essence, fun was described by Fuchs, Fizek, Ruffino and Schrape (2014) as a product of an understanding of game systems and interacting with them in meaningful gameplay that is enjoyable to the player. This involves a level of gaming literacy, which is an understanding and ability to interact effectively and purposefully with a game's rules and systems. Using examples of gamification like a gamified teeth-brushing application called Kolibree, Fuchs, Fizek, Ruffino and Schrape (2014) demonstrate how even with gamified implementations like point systems and social networking if there is a lack of player interaction and meaningful gameplay, the fun does not arise. Though requiring different strategies and difficult to encapsulate, fun is a key gamified component that must be considered if implementing gamification in introductory educational modules.

Finally, the project studied existing practical applications of gamification in architectural education. Schnabel (2014) demonstrates not only a gamification framework for architectural education but also a demonstration of these concepts used to create a bottom-up urban mass housing project. Schnabel's project specifically examines engagement and social dynamic-focused implementation in play environments with the explanation of 'good' game elements consisting of mechanics, dynamics, and aesthetics. Mechanics consisted of the technical components of the game and environment, Dynamics consisted of the player engagement and interaction with in-game elements/environment, and Aesthetics consisted of unique emotional reactions such as discovery and competition created by social interaction and game elements. These elements were utilized consecutively and experienced by the player in reverse as the participant moves from an initial 'fun-based' emotional interaction with the game before developing a behavioural understanding of processes that leads to the technical mastery of in-game elements. Schnabel concludes a demand and potential for new research meant to create an integrated system meant to not only facilitate architectural education but also greater communication on larger design projects between the architect and users.

Redondo et al. (2020) presented a utilization of gamification, AR/VR technology, and game design in training future architects through EDUGAME4CITY: a financed research project completed under the Master y Grade de Arquitectura of the ETSABarcelona-UPC.

EDUGAME4CITY consisted of a multi-step viability study applied to urban design projects undertaken by architecture students. Urban intervention projects were completed by students utilizing optional gamified elements and technology such as VR modelling and gamification components. The projects revealed and supported many hypothesized elements of gamification in architectural education such as providing a way of evaluating the necessity and appropriateness of a design before construction, the benefit of extensive replicable simulations able to be analyzed from multiple points of view, and positive engagement and skill retention from students. Reflecting the delineation between new declarative and procedural knowledge shown in Lawson and Oxman's works, students demonstrated improvement of concepts in both forms of knowledge as well as practical skill sets including but not limited to the understanding of abstract relationships, the impact of research and analysis based ideas, comprehension of the project process, and spatial competency and technological mastery. Redondo also delineated an educational framework designed to accurately compile data from student experiences and performance based on a telematics-based survey model. These results demonstrated key factors to consider in research such as students highly valuing 3D visualization as a means of understanding space but also struggling with several complications such as the difficulty of technological use, the inability to perceive higher quality renders and models on mobile devices, and heavy file sizes preventing easy dissemination of completed projects. These results as well as the project's complications reflect issues of game literacy and potential technological limitations that must be overcome in order to advance and proliferate gamification in architectural education. However, these case studies examined together demonstrate the data-driven positive benefits of gamification utilized by architecture students, especially in regard to urban environments and urban design projects.

TOOLS

In addition to game design principles and gamification, game-related technologies such as augmented reality and virtual reality were also reviewed due to their value in exercising the spatial and technical skills of architectural education with minimal waste while also creating avenues for greater understanding of student surroundings and social networking amongst peers. Due to how interwoven game technologies and gamification principles can be, the paper has chosen to examine both in regards to introductory education.

Bertuzzi et al. (2018) in 'Gamification of Educational Environments through Virtual Reality Platforms', showed the use of augmented reality as a means of teaching spatial skills and societal understanding (values, attitudes, rules, etc..) in addition to traditional educational topics. Utilizing virtual reality headsets and a programmed virtual environment, Bertuzzi demonstrated how an open 3D digital environment could be combined with the existing physical space of the authors' university to create an augmented reality inhabited by smart objects, game avatars, and a rule/task system. Players would then be able to interact with virtual objects only visible to the participants while also engaging with the actual physical locations of the environment itself, teaching traditional academic concepts in a multi-dimensional way that also tests spatial understanding and knowledge of their local customs, attitudes, and values. Due to the large resource and design limitations, the augmented reality system remains difficult to reproduce at scale. Further, issues with game literacy (an understanding of game rules and systems) as well as physiological issues related to nausea and discomfort from extended use of virtual reality apparatuses stymied greater widespread implementation. However, despite the lack of current existing case studies, augmented and virtual reality as demonstrated by Bertruzzi shows potential in being applied to introductory architectural education due to the way in which the technology could allow students to learn spatial and societal skills in an integrative, engaging way.

Varinlioglu, and Halici (2019) showcased the potential of AR gamification technology by creating a digital variation of public archaeology that encouraged engagement through digital games, social media, and mobile technology. The study designed, implemented, and tested a prototype archaeological augmented reality game. The game used object tracking to turn real on-site artefacts into "smart objects" that functioned as objects tracked in the digital space, offering challenges and providing additional information on the archaeological significance. Using scavenger and treasure hunt formats in addition to location-based storytelling and these smart objects, Gamification has generated popularity and success in heritage, archaeological, and preservation fields due to creating new ways of interacting with environments/information, increasing visitor involvement, and reducing costs and risk to actual archaeological sites. Varinlioglu and Halici's (2019) augmented reality

the game demonstrates the efficacy of not only the technology but also the combination of digital geography, and storytelling gamification to educate newcomers to a highly technical field.

Zarzycki (2014) discusses applications in which augmented reality is utilized including an app for a fashion-based social event that enables participants to preview current collection additions, an info-navigational app for the Tall Line raised urban park in New York City, a marker-based maze game, and an interior decorating interface to visualize various furnishing scenarios.

Virtual environments allow design students to explore inaccessible and conceptual designs without committing resources, time, or work to physical

architecture. The project aimed to implement virtual gamified principles and augmented/virtual reality to improve and create a collaborative environment, Though not aimed at beginner students, the project selected five virtual gamified urban scenarios that the students of Máster y Grado de Arquitectura of the ETSA Barcelona-UPC of landscape and urban design used to develop urban intervention programs. Redondo et. al (2020) designed these scenarios with the mindset of improving spatial reasoning in non-experts while also incentivizing greater participation and enjoyment. Through this course that focused on using video games to teach architectural representation, students were charged with modelling space using different software, analyzing methods and their own learning

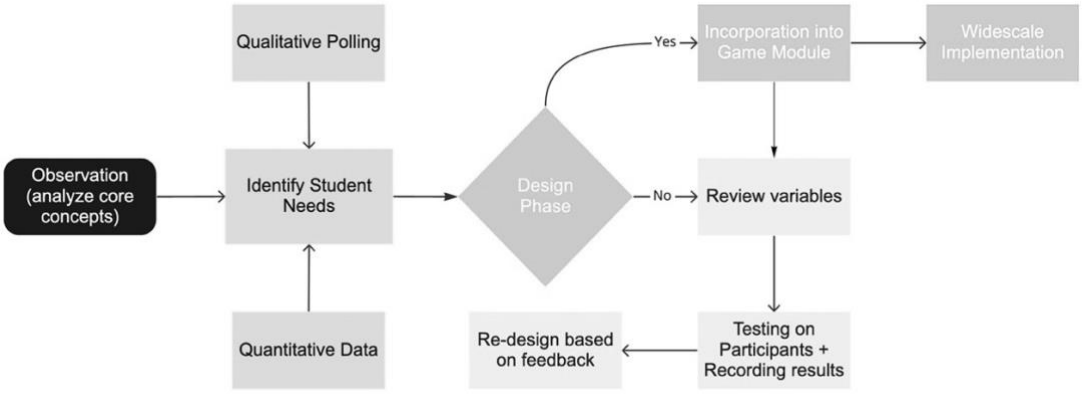

Figure 3: Potential Gamification Workflow Diagram

spaces. Unlike other more sedentary games and class activities, AR frameworks incorporate real-world physical movement and social interaction as well as incentivise exploration, learning, and discovery. AR tech is entering a new stage where it's now no longer exclusively the domain of individuals with large amounts of capital or technical knowledge. Products such as Vuforia, Qualcomm's plugin for the Unity3D Game Engine, serve as exceptionally functional tools that can readily be incorporated into academic teaching and professional practice.

This greater ease of access indicates the possibility of design schools embracing AR tech as a new creative and data visualization medium. However, one of the largest obstacles Zarzycki discusses that would need to be overcome is the creation of community building with a critical mass of active users needed in order to populate and interact with the virtual landscape. Many new products in the AR community especially those related to education or developed by students often struggle with maintaining the user base necessary for

Finally, Redondo et. al (2020) demonstrate the closest prototype to utilizing gamification to teach introductory

experience and produce interactive content with real-time rendering. In communicating proposals, architecture students rely on visual representative technologies to express their skills. Video games and gamified systems offer tasks with high spatial components and complex visual models that create a favourable interactive application for architectural skill development. Though 3D space visualization has traditionally been done through drawings and models, 3D models and virtual technologies have emerged as useful tools to better educate students.

CONCLUSION

Architectural introductory education requires a complex, multi-faceted skill set and nuanced understanding of abstract concepts to build the foundations necessary to become an architect. With the success of similar gamified educational products demonstrating the feasibility of applied concepts, the existing body of literature demonstrates the potential benefits of utilizing gamified elements (point systems, social networks, etc..) as well as game technology in the form of augmented/virtual reality to create an engaging, entertaining,

and educational environment for introductory design students.

A possible evaluation framework for gamifying educational modules would consist of five distinct phases. The first phase would consist of analyzing the course curriculum and analyzing exercises in order to identify the core knowledge, skill-based concepts, and techniques as outlined by the evaluation criteria analyzed in the Literature Review. Once the concepts have been identified and organized by skill set, phase two consists of taking both quantitative data based on existing student metrics (grades, test scores, etc..) as well as qualitative polling of participant need with a focus on issues based on retention, engagement, and understanding. Phase three consists of the design phase in which gamified concepts are applied accordingly. Structural components like point systems and social networking can be overlaid in place of traditional grading and collaboration models but separate evidence-based design work can occur to create games, gamified exercises, and curriculum tied back to improving the skill sets identified and organized in Part 1. Phase four consists of testing and recording results from participants in a similar data and opinion-focused style as phase two with the intention of entering the final phase five of reviewing and re-designing based on individual class feedback.

Gamification is not without its detractors, critics, and flaws. Bogost (2015) elaborates in the aptly titled 'Why Gamification is Bullshit', on the fact that gamification has been poorly implemented by profit-driven consultants and businesses and has generated a reputation as a practice used by those who sought to exploit opportunities for their benefit. Due to gamification's sudden appeal and popularity in sectors like business management, the practice has been abused by those who oversell games and gamification as solutions instead of addressing the problems at hand. Bogost described how game designers and game developers have shown resistance to the widespread implementation of gamification because the practice often engages in only superficial properties of the medium like points and leaderboards instead of the more complex, fundamental design and play of real-time system-driven simulations. Gamification in this regard exists only as a type of consulting that utilizes games superficially instead of as a style of design or game implementation. This superficial implementation of gamification should be avoided when applied to introductory educational modules in favour of deeper more meaningful design in order to create the environments, rules, and interactions necessary to create the experience of play. In essence, to avoid these pitfalls, future projects should increase user interaction to allow for deep learning, encourage participant engagement to the point of developing communities, and design mindfully to purposefully integrate and implement gamification principles when appropriate.

Though obstacles exist in terms of game literacy, scale, and implementation exist, gamification and game design principles hold great promise in improving the educational conditions of architectural students, teaching difficult concepts such as spatial understanding in an engaging way, and paving the way for future implementation of new technologies in the field.

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