Architecture Education and the Approach of Learning via Digital Gaming

Akeredolu G.R
Department of Computer Science
Federal Polytechnic
Idah – Nigeria
akmasgbenga3@gmail.com

Elusoji A.A PhD
Department of Computer Technology
Yaba College of Technology
Yaba – Lagos, Nigeria
elusoji872@yahoo.com

Odii J. N. PhD
Computer Science Department,
Federal University of Technology
Owerri, Imo-State, Nigeria
jnodii@yahoo.com

Akanji A.W.
computer Science Department
Lagos State Polytechnic
Lagod, Nigeria
Wasak2005@Yahoo.Com

Aiyegbusi A.E
Department of Computer Science
Micheal Otedola College of Primary Education
Epe-Lagos, Nigeria
aiyegbusied@yahoo.com akmasgbenga3@gmail.com

ABSTRACT

In today's digital age, it is recognized that learners, who are born in a world of technological resources, cannot be educated via conventional methods. As in many other fields, rapidly advancing technology caused certain revisions in the field of education. In today's architecture education, the utilization of digital games is one example of the mentioned revisions. The idea of an active and experiencing learner in an environment where knowledge is not transmitted to the learner rather constructed through activity like games is an approach to constructivist learning. Learning games are not just a genre of games, but a unique and emerging field that operates at the intersection of game designers, learning designers, subject matter experts, developers, educators and researchers, who collaborate to produce innovative and powerfully engaging learning experiences. This paper aims to highlight the principles of Games Based Learning (GBL), integrating games into formal educational settings, and presented a GBGame that simulates building construction in plots zoned for different land uses within the framework of city development.

Keywords: Architecture education, Game Based Learning, Digital Games, Gamification

1. INTRODUCTION

Architecture education is a dynamic field which is quite open to interdisciplinary research, different instructional approaches, and to innovative implementation and experimental studies of these approaches. The main approach in architecture education is the student-centered, process-driven constructive approach and the project-based learning [1]. This approach to education, which is project driven and based upon learning by doing, may occasionally need to be supported by different instructional strategies, methods and techniques. Fieldtrips, creative drama sessions, games and various alternatives may fall within architecture education, and may be used to increase the achievements aimed. Games can make learning concept more enjoyable for students and provide a platform for their creative thought. Games will often act as learning triggers inducing lively discussion on learning concepts amongst students following game play. A couple of new ways of teaching like Game Based Learning and Gamification can be applied to enhance the learning procedure of students in various age levels. Game-based learning refers to the borrowing of certain gaming principles and applying them to real-life settings to engage users.

The motivational psychology involved in game-based learning allows students to engage with educational materials in a playful and dynamic way [5]. Gamification focuses on the application of game mechanics and gameful thinking in non-game contexts to engage users in solving problems or carrying out tasks. In educational games, we could combine the elements of fun and educational concepts to increase student's motivation and engagement. We believed that using game-based learning is better than traditional lecture instruction, producing better learning effects and higher learning motivation. Being more attractive to learning attention of students compared to traditional instruction, they can increase learning motivation promote problem-solving ability, and result in achieving better learning effects [6]. The remainder of this paper shows the main principles of GBL, integrating games into formal educational settings, working with Game-based Learning in educational settings, the development and design of a GBGame

2. LITERATURE REVIEW

Games have been recognized as being a good tool to promote learners to actively participate in learning activities. Researchers have indicated that game-based learning could be the best way to trigger students' learning motivation. In addition, it has been reported that a game-based learning approach might provide a good chance to stimulate learner's abstract thinking during the process of cognitive development, and further foster their higher order thinking ability [4]. Computer games are able to boost motivation owing to some characteristics, such as adventure, challenge and freshness. Therefore, if instructors are able to apply computer games to teaching, students can not only have better learning achievements, but also learn happily via these games. Several previous studies have demonstrated the ease of use and usefulness features of computer games by applying the game-based learning approach to a variety of learning activities [7].

Using computer games for learning can increase the internal motivations and learning achievements of students and their competences and knowledge can be promoted [16]. There are several theories that are recognized as being relevant to the game-based learning approach, such as cognitive theory and situated learning theory. Cognitive theory emphasizes that learners should master basic skills to further acquire higher-level abilities while learning new things. It also emphasizes that learning processes are progressive and move from simplicity to complexity; moreover, games that are adopted need to stimulate students' learning motivation and make learning more fun [20]. Situated learning theory states that learners should enter learning scenarios to acquire knowledge. The knowledge that is actively explored in the scenarios should not only be useful, but should also be analogical [19].

Therefore, establishing a rich learning scenario enables learners to gain practical problem-solving abilities via observation and behavioral exploration, and a well designed game is able to provide such a learning scenario. Some researchers believe that even the best teaching materials and techniques are not as good as having a learner to learn happily via games. Compared with other media, games are closer to the learner's world and are easily accepted by them and can help develop problem-solving skills [12].

3. PRINCIPLES OF GBL

1. Intrinsic motivation - Gaming is intrinsically motivating because by and large it's a voluntary activity. Therefore, gaming for learning works best in the context of invitation and persuasion, rather than compulsion.
2. Learning through intense enjoyment and "fun". Several authors suggest that games can be a vehicle for engaging students in a "flow". Flow is a state of consciousness during which an individual is in control of his actions and completely absorbed in the task at hand.
3. Authenticity. Authenticity means a concern for the real nature of learning, which is supposedly different from the "artificial" or decontextualised forms of learning that take place in schools. In the name of authenticity, contextual skills are prioritised over the abstract notions and facts valued in traditional instruction. Therefore, "good" gaming reflects actual learning processes, which are always grounded in specific settings and practices. These can be actual professions, but also extravagant, fantastic roles and endeavours.
4. Self-reliance and autonomy. Gaming encourages independent inquiry and exploration; interests and passions can branch off from the individual game, towards aspects of the "ecosystem" that surrounds it. These aspects include technical and artistic skills like programming, writing, drawing, making music; but also the desire to find out more about certain topics , e.g. about science, history or mythology.
5. Experiential learning. The notion of experiential learning is a very old and influential one in education, many researchers claim that gaming provides a cost effective alternative to learning by doing in real settings

4. INTEGRATING GAMES INTO FORMAL EDUCATIONAL SETTINGS

Formal educational settings impose some restrictions on how a game can be played, as well as requirements on how it needs to function. As such, educational games are no different from other types of software that are to be developed and used in organizational settings [10]. For educational games, the infrastructure of formal education presents many significant challenges. Infrastructure is a combination of local and broader situational factors, such as national or regional parameters. Local parameters can, for instance, be the local culture and social attitudes towards games in education among instructors, legislators, and parents, or individual instructors' game and technology literacy.

National or regionally dependent parameters can be curriculum guidelines, budget constraints, or school term schedules. The local parameters are, on the one hand, somewhat malleable, but can, on the other hand, severely limit the broader applicability of an educational game since it is difficult to create a game that can accommodate the differences between different educational institutions. Properties of national parameters are comparatively reversed; rigid, but largely uniform between different educational institutions. Table 1.1 is a summary of the more prevalent situational factors related to formal educational infrastructures identified through the interviews and case studies conducted in this research. A broader categorisation of the three aspects of formal educational settings that needed to be taken into special consideration during educational game integration and use.

Table 1.1: Summary of situational factors related to formal educational infrastructures

Category	Situational factors: participants, technologies, and practices
Human factors	Cultures and attitudes
	Parental considerations
	Students' interpersonal relationships
	Students' proficiencies and preferences as learners and game players
	Teachers' experience and expertise: • Gaming literacy • Technology and computer literacy
Technological factors	Device availability (e.g. PCs, tablets)
	Network availability and security
	Technology reliability
	Information storage and access
Organisational structures and praxis	Schedule constraints
	Classroom sizes and Educator:Student ratio
	Curriculum guidelines
	Management and supporting entities

The infrastructure factors that affect the application of educational games can be divided into human, technological, and organisational factors [14]. Some examples of human factors are an instructor's experience of and expertise in using educational games, students' gaming literacy, or developers' and educators' ability to communicate across their respective disciplines. The instructor needs to understand the game, in order to understand what students are doing within it and to be able to translate game progress to curriculum progress and learning objectives [6]. The instructor also needs to be proficient in setting up play sessions in a limited amount of preparation time, as well as assign tasks and support their students during the play sessions. Instructors are also important conduits between the learning context and the play context, and need to know how to contextualise the game content to the subject matter being taught [11]. An understanding of the game being played can also be important for evaluating a student's progress through the curriculum.

The integration of the educational game and the designs of the game-based exercises it is going to be used for, also need to allow for students' familiarity with games as well as the taught subject matters [15]. Finally, it is also important that the game software is well linked to the educational setting, which the communication between the developers and educators can greatly affect. The culture and attitudes in an educational institution must also be receptive to games as a medium. Regarding the technological side of educational games, instructors need to be able to orchestrate a lot of complex technical components if they are to use digital game-based learning as a part of their teaching process [3]. Reliability and stability are crucial requirements for any educational game to be an attractive or even feasible proposition for classroom implementation. There are also more complex matters of being able to monitor play sessions, either in real-time in order for instructors to moderate classroom activity, or retroactively for the assessments of students' progress in the curriculum. For instance one approach is to provides instructional manuals for instructors that explain how the game-based activities should be introduced and how debriefing classroom discussions can be conducted [21].

Another approach that is somewhat more advanced and technical is to implement ways of tracking various metrics from play sessions, for instance, providing data of students' destinations in a game, the characters they encountered and the dialogue options chosen, or how the student interacted with the game world [22]. Making such data available for instructors is, however, only valuable if the instructor knows how to interpret it, so it can require some training on the part of instructors. Nevertheless, incorporated means of student assessment can be a potential way of making an educational game more appealing to instructors. Merely designing a game with subject matter content and game mechanics in mind may thus not be enough to ensure that a game can have an impact in formal educational settings. Managing to integrate an educational game into a formal educational setting, and reaching the objectives that one might strive for when doing so, require that developers and educators either restructure obstructive organisational elements or implement solutions in the used software to accommodate them (see Figure 4.1).
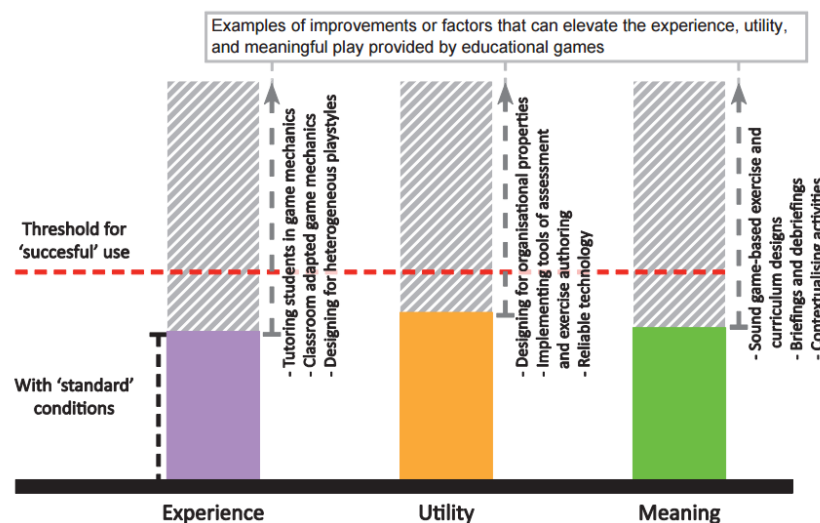

Figure 4.1: A visualisation of what types of improvements can be needed for educational games to have a successful impact in formal educational settings.

Taking a thorough inventory of the available hardware and resources as well as researching what to expect from the software being integrated are crucial for making the process of integration as smooth as possible.

5. WORKING WITH GAME-BASED LEARNING IN EDUCATIONAL SETTINGS

Essentially, establishing and carrying out a game-based curriculum is a two-part process: one part in which the educational organisation and environment is surveyed and prepared to receive and work with an educational game; and a second cyclical process where learning objectives and students' progress are continuously reviewed, and game-based activities are designed and prepared to accommodate them [17]. These two processes are summarised in Figure 5.1.
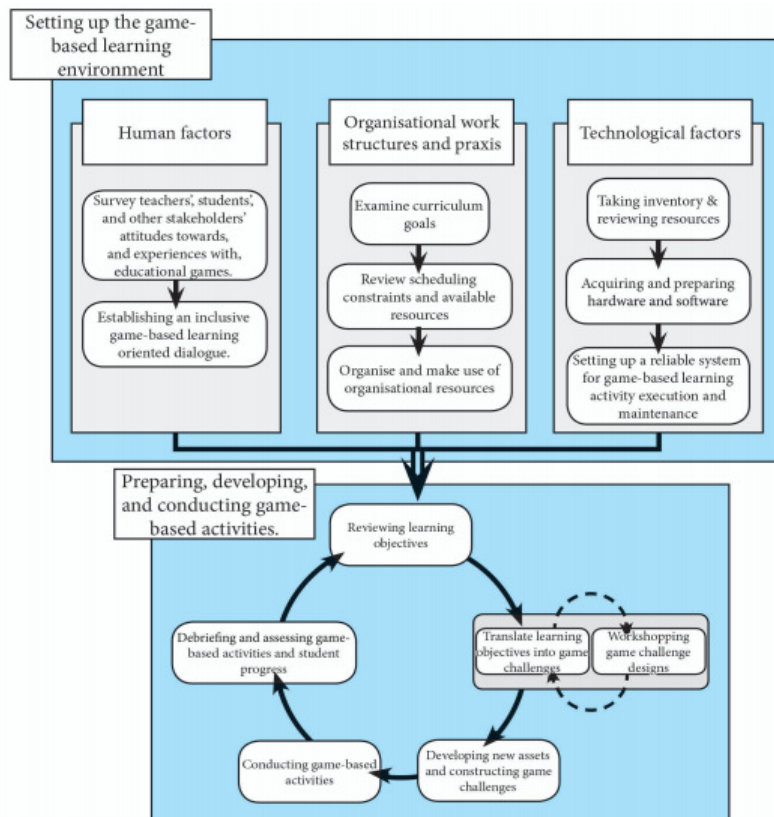
Figure 5.1: Combined model for the integration of an educational game in a formal setting, and the cyclical working processes involved in executing continuous exercises throughout a game-based curriculum.

6. DESIGNING, CREATING AND CONDUCTING GAME-BASED LEARNING ACTIVITIES

The design and creation of a game-based curriculum and its activities start with an examination of what type of game (and what type of specific game mechanics) corresponds well to the pursued learning objectives. The cyclical process of preparing and conducting game-based activities settled into six discernible steps (shown in Figure 6.1). Initially, learning objectives had to be reviewed in relation to the students' current progression through the curriculum. After identifying new learning objectives to focus on, or old learning objectives that the students would benefit from repeating, new game challenges could start to be designed. The design process consisted of an initial ideation process, where the learning objectives were 'translated' into new game challenges, and the presentation of a rough draft of the new challenge designs to the working group for reviewing [18].

The process of designing challenges, presenting a draft, and reviewing it as a group would be repeated until the challenge met everyone's requirements. Thereafter, the game challenges were created and implemented into the game, distributed to the instructors and the students, and subsequently put to use during game-based sessions. After debriefing the game-based sessions with each other and assessing the students' progress and reception of the game-based challenges, learning objectives were once again reviewed and thus the cycle started anew.
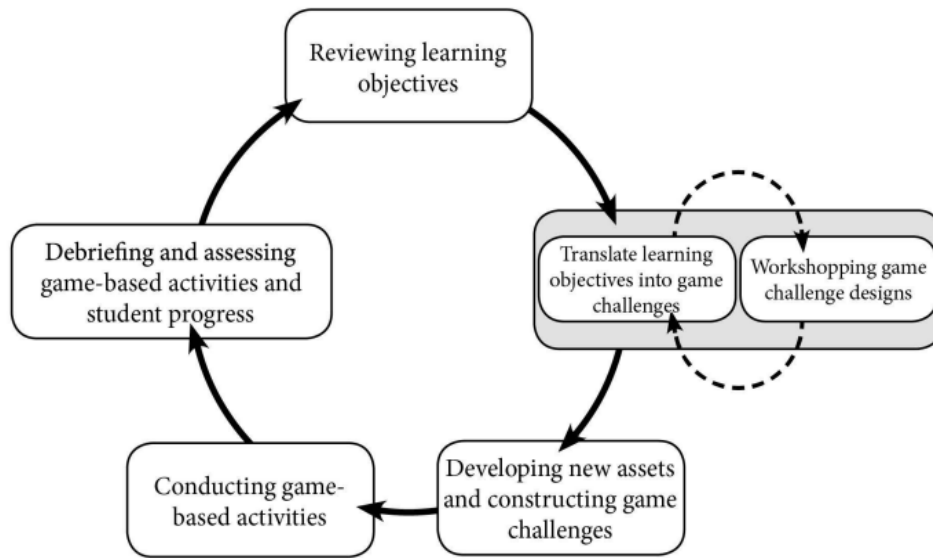
Vol. 2 No. 3, September 2016

Figure 6.1: The cycle of game-based activity preparation, execution, and assessment.

7. Development and Design of the GBGame

7.1. Concept

The GBGame presented in this research simulates building construction in plots zoned for different land uses within the framework of city development. Within a given budget, players can construct buildings using construction cards and function cards that allow various strategic actions and implement various green building technologies to achieve the ultimate goal of developing an ecologically sound city.

Figure 7.1 Schematic diagram of the game.

7.2. Game Materials

The physical aspects of the game (Figure 7.1) are comprised of base boards, cards, and tokens. The 19 hexagonal base boards simulate city plots dedicated to one of four land uses: commercial (red), industrial (coffee), residential (yellow), and agricultural (green). There are three types of cards: 72 construction, 32 function (including cards that spur interaction among the players as well as cards representing various green building technologies or strategies), and 35 environment. Tokens are divided into the following three types: Player tokens: These are cylindrical markers representing the player's ownership of given lands; they are divided into five colors (to allow for five unique players), with four tokens for each color (one for each type of land use). Building tokens: These are made up of three groups (Building A, B, and C) of 16 cubes each in three different colors and heights, representing building grades, which are upgradeable. Green technology tokens: These are two-sided 20 green and black semicircular function markers. The green side represents green building technologies that have been applied in the buildings, whereas the black side represents punitive deductions for the lack of a green building concept.

7.3. Sequence of the Game

Figure 7. 2 presents the steps of the game, which are as follows:

1. Starting action: The base boards are placed randomly in a clockwise direction. Then, the construction cards and function cards are shuffled and dealt to every player, after which the players choose a color for the tokens that represent their roles and claim one board of each respective land type.
2. Dealing environment cards: One environment card is dealt before the start of every round to simulate one of the ecological challenges faced by cities. For example, if a player extracts an environment card that reads "Environmental condition: global climate change has led to the worsening of urban heat island effects" and the player's building has either a "Water-permeable pavement" card or a "Green roof" card—either of which mitigates the heat island effect—the player is exempt from the negative effect and is awarded one scoring token.
3. Routine actions: Players can select one action for execution each round; examples include purchasing land, constructing a building, and investing in green building technologies. After completing construction of a building, players can also decide whether to sell land. In addition, cards can be strategically traded for new cards from the draw pile.
4. Special action: Players can interact with one another in various ways during the game process using the function cards. For example, a player may play a function card affecting another player, such as "Excessive CO emissions from building materials" or "Failure to meet waste reduction benchmarks." If the other player has not yet invested in green building technologies pertaining to these adverse developments, s/he pays the fine noted on the function card (reducing his/her score by one point) or is suspended for one round as punishment. In addition, function cards can be used to add value or defend against attacks by other players. For example, a player may be rewarded for using the "Water-saving technology" function card while defending an attack by another player's "Drought" function card. The aim is to encourage players to use as many function cards as possible for strategic purposes; in addition to being helpful in progressing the game, the use of these cards helps players to acquire more knowledge related to green buildings while playing.
5. Ending action: To prevent players from expanding their lands infinitely, the game ends when any player sells his/her fourth piece of land. However, this does not imply that that player has won the game; rather, each player's total number of gold coins is calculated (one point for each coin), with additional points awarded for various features (five additional points for each Grade A building, three additional points for each Grade B building, and one additional point for each Grade C building), and the total amount of green building technology rewards earned is calculated (one additional point for any one type of green building technology investment); deductions are also made (one point for each deduction token). The player with the highest final score wins the game.
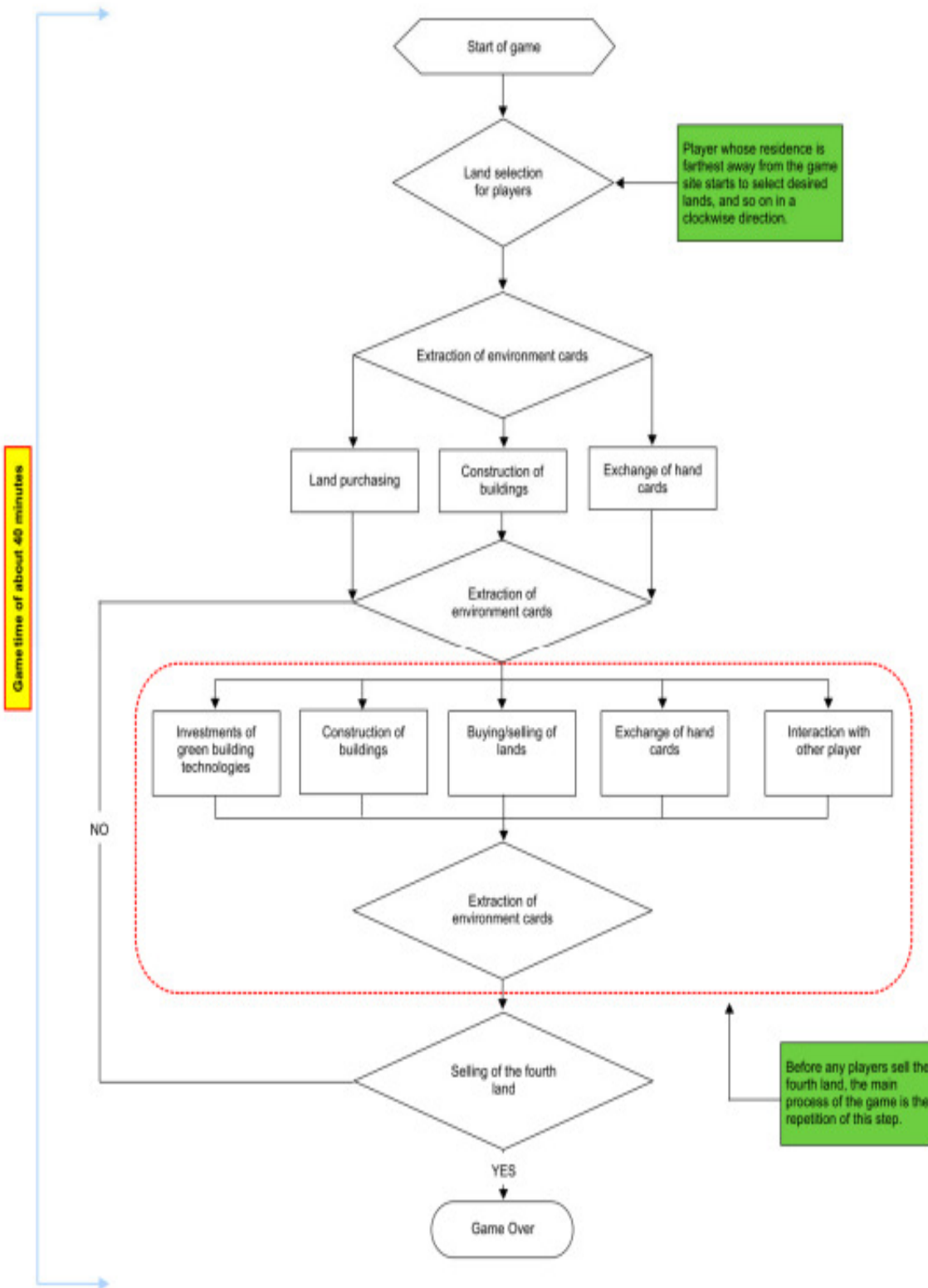
Figure 7. 2. Flow diagram for game steps.

8. CONCLUSIONS

In this study, the theory of architecture education and the approach of learning via digital gaming as a new development are elaborated. As a result of this review, in an event that theoretical common ground is set, it is concluded that digital games may be utilized in architecture education. The field of learning games is standing on the horizon of many exciting things ahead. Assessment and data are key themes in this field, and for good reason—they provide us with powerful tools to create better learning experiences, and to help us better understand learning in game-based environments and beyond. Data is an abundant resource in games, if we know how to use it. We are moving toward an era where click stream data in games offers us a rich sea of information to use to our advantage—and to the advantage of our learners. The field of learning games will be measured by how well we achieve the fundamental goals of creating learning games as powerful learning experiences to help learners break through ideas in bold new ways.

REFERENCES

[1] Blumberg, F. C., Rosenthal, S. F., & Randall, J. D. (2008). Impasse-driven learning in the context of video games. Computers in Human Behavior, 24(4), 1530-1541.

[2] Bourgonjon, J., Valcke, M., Soetaert, R., & Schellens, T. (2010). Students' perceptions about the use of video games in the classroom. Computers & Education, 54 (4), 1145-1156.

[3] Carbonaro, M., Szafron, D., Cutumisu, M., & Schaeffer, J. (2010). Computer-game construction: A gender neutral attractor to Computing Science. Computers & Education, 55(3), 1098-1111.

[4] Chu, H. C., Hwang, G. J., Tseng, Judy. C. R., & Hwang, G. H. (2006). A computerized approach to diagnosing student learning problems in health education. Asian Journal of Health and Information Sciences, 1(1), 43-60.

[5] Chu, H. C., Hwang, G. J., & Tsai, C. C. (2010). A knowledge engineering approach to developing Mindtools for context-aware ubiquitous learning. Computers & Education, 54(1), 289-297.

[6] Chu, H. C., Hwang, G. J., Tsai, C. C., & Tseng, J. C. R. (2010). A two-tier test approach to developing location aware mobile learning system for natural science course. Computers & Education, 55(4), 1618-1627.

[7] Cuenca López, J. M., & Martín Cáceres, M. J. (2010). Virtual games in social science education. Computers & Education, 55(3), 1336-1345.

[8] Dabaj, F. (2009). The role of gender and age on students' perceptions towards online education. Case study: Sakarya University, Vocational High School. The Turkish Online Journal of Educational Technology, 8(2), 120-123.

[9] Delialioglu, O., Cakir, H., Bichelmeyer, B. A., Dennis, A. R., & Duffy, T. M. (2010). Factors impacting adult learner achievement in a technology certificate program on computer networks. The Turkish Online Journal of Educational Technology, 9(2), 97-107.

[10] Dickey, M. D. (2010). Murder on Grimm Isle: The impact of game narrative design in an educational game based learning environment. British Journal of Educational Technology. doi:10.1111/j.1467- 8535.2009.01032.x

[11] Huang, W. H. (2010). Evaluating learners' motivational and cognitive processing in an online game-based learning environment. Computers in Human Behavior. doi: 10.1016/j.chb.2010.07.021

[12] Huizenga, J., Akkerman, S., Admiraal, W., & Dam, G. T. (2009). Mobile game-based learning in secondary education: engagement, motivation and learning in a mobile city game. Journal of Computer Assisted Learning, 25(4), 332-344.

[13] Hwang, G. J., & Chang, H. F. (2011). A formative assessment-based mobile learning approach to improving the learning attitudes and achievements of students. Computers & Education, 56(1), 1023-1031.

[14] Hwang, G. J., Chu, H. C., Shih, J. L., Huang, S. H., & Tsai, C. C. (2010). A decision-tree-oriented guidance mechanism for conducting nature science observation activities in a context-aware ubiquitous learning environment. Educational Technology & Society, 13(2), 53-64.

[15] Hwang, G. J., Tsai, C. C., & Yang, S. J. H. (2008). Criteria, strategies and research issues of context-aware ubiquitous learning. Educational Technology & Society, 11(2), 81-91.

[16] Hwang, G. J., Shih, Y. R., & Chu, H. C. (2010). A concept map approach to developing collaborative Mind tools for context-aware ubiquitous learning. British Journal of Educational Technology. doi: 10.1111/j.1467-8535.2010.01102.x

[17] Imhof, M., Vollmeyer, R., & Beierlein, C. (2007). Computer use and the gender gap: The issue of access, use, motivation, and performance. Computers in Human Behavior, 23(6), 2823-2837.

[18] Kim, B., Park, H., & Baek, Y. (2009). Not just fun, but serious strategies: using meta-cognitive strategies in game-based learning. Computers & Education, 52(4), 800-810.

[19] Lee, C. Y., & Chen, M. P. (2009). A computer game as a context for non-routine mathematical problem solving: the effects of type of question prompt and level of prior knowledge. Computers & Education, 52(3), 530-542.

[20] Shih, J. L., Shih, B. J., Shih, C. C., Su, H. Y., & Chuang, C. W. (2010). The influence of collaboration styles to children's cognitive performance in digital problem-solving game 'William Adventure': A comparative case study. Computers & Education, 55(3), 982

[21] Squire, K. (2005). Game-Based Learning: Present and Future State of the Field. Madison, WI: University of Wisconsin-Madison Press.

[22] Antiqueira, R.I.; Vizioli, S.H.T.; Antiqueira, K.M. (2015). Digital Game and Drawing in Heritage Education   Teaching,http://www.iau.usp.br/pesquisa/grupos/nelac/wp-content/ uploads/2015/12/sigradi_renan.pdf, Access Date, 07/05/2016.