

The Arckitbuilding Bricks as a Didactic Tool for Experimentation in Architectural Design: Possibilities and Limitations

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Abstract: This article deals with the usage of building bricks as a didactic material for the development of architectural design. The building brick game chosen for analysis was the Arckit, since it is suitable for the architectural practice. It is estimated that this game can contribute to the design, representation and presentation of projects. In order to investigate in which aspects Arckit presents possibilities of applications, as well as limitations of use, the article approaches the importance of building bricks as a didactic tool and its use in the field of the architectural design process. From a literature review and an empirical experience, this article reports a qualitative research, where the applicability of the Arckit game was checked. Through a critical reflection based on that experience, it was possible to conclude that whereas its limitations to urban form and linked to the formal vocabulary that composes the grammar of these bricks, the Arckit building bricks represent in architecture a playful and experimental way to think and design, fomenting the creativity and the spatial perception, resulting in a particular experience that can make architecture better connected with dreams and joy.

Key words: Physical model, building bricks, didactic tool, education, design, architecture.

1. Introduction

In the recent history of architecture, computational technologies have become increasingly important and, as a consequence, a widespread tool in the process of representation and design of architecture and urbanism [1]. It can be asserted that the introduction of new technologies in the field of architecture has, in the last decade, boosted the exploration of three-dimensional models in the development of the design process [2]. However, such digital models are abstract products, since they are virtual three-dimensional representations, projected in two-dimensional bases.

The great revolution has been shown with 3D printers and other rapid prototyping tools and digital

fabrication [3] because they can materialize what previously could only be seen on the computer screen. These printers are able to build the physical, concrete models with which architects can properly test their designs.

In this context, physical models remain present as an effective tool in the scope of the architecture, since they are representations whose dimensions correspond with the architectural space language. Through them, interdisciplinary knowledge is built, and it is possible to develop cognitive, artistic and technical skills that involve promotion of creativity, scale comprehension, representation of space and a critical logic about architectural design.

Based on these questions, this article proposes a reflection on the use of building bricks toys in the teaching-learning process of architecture, particularly in relation to the experimentation and

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three-dimensional representation of projects through physical models. More specifically, we have seen the use of Arckit, one of the most suitable building bricks game for architecture practices available in the market.

Methodologically, this article is composed by a literature review and an empirical experience, carried out in a workshop, in which students from the undergraduate course of Architecture and Urbanism at the Federal University of Juiz de Fora participated. For the study of the use of Arckit building bricks, the following categories of analysis were established: (1) formal language; and (2) usability.

This article is organized in eight sections, so that the first two aim to rescue the use of building bricks as a didactic material and present their application in the field of architecture. The other sections deal with the context in which the research was carried out, it means that they discuss the categories of analysis established, the Arckitbuilding bricks, the empirical project experience and the discussion of the results.

It is important to emphasize that the main purpose of this research is to present a discussion about all possibilities and limitations of the use of Arckit building bricks as a didactic tool for experimentation in architectural design.

2. The Use of Building Bricks Games as a Didactic Tool

Building bricks are currently in use for educational practices. Besides being a playful object, they are also didactic and pedagogical tools, used in teaching-learning processes.

The bricks, understood as games, as concrete material, were systematically used by Vygotsky and Piaget in the field of education and also widely explored by Montessori constructivist pedagogy [4].

Analyzing the use of building bricks throughout history, we can adopt as a starting point the blocks of Fröbel, better known as Fröbel Gifts. The German educator Friedrich Wilhelm August Fröbel created the first kindergarten system based on games and ludic

activities [5].

Fröbel asserted that playing was an experience through which children created meaning and also made it possible to understand the functioning of objects and actions, understanding their role as creative agent in the world. Fröbel's blocks have expanded into the market for educational tools for a long time, stimulating logical, ludic, rational and spatial reasoning.

The Fröbel blocks, which were made of wood, have several versions and can be used to reproduce real life, even in an abstract way, simulating houses, castles, towers and bridges, for example. The pieces also enable the understanding of three spatial dimensions, develop mathematical reasoning and can be rearranged into new forms and compositions, developing notions of volumes, proportions and symmetries.

In addition to the Fröbel blocks, LEGO building bricks must also be mentioned as powerful didactic tools. In the 1980s, the company entered into a partnership with the MIT (Massachusetts Institute of Technology), giving birth to what we still have today: LEGO Education, which "provides a continuum of hands-on playful learning tools that engage every student's natural curiosity, and help them develop the skills and confidence they'll need in the future" [6].

3. Building Bricks in Architecture Education

One of the qualities required to practice the profession of architects is certainly creativity, "an inherent potential for man" [7]. However, not all architecture students, especially in early stages of the undergraduate course, are fully creative. Thus, it is necessary that disciplines, both practical and theoretical, must be able to stimulate students to improve this competence. The same can be asserted about the development of the formal and spatial understanding capacity of architectural projects.

Therefore, building bricks can be used as teaching tools in the context of architecture education. Building bricks constitute a design world, since they provide a three-dimensional formal repertoire, analogous to

reality, which through formal grammar can stimulate students to find some design solutions.

According to Mitchell [8], formal possibilities of conception are part of a design world, that is, a universe of restricted possibilities that varies according to the working tool. Therefore, the possibilities of experimentation of architecture, considering building bricks, have a direct effect on the range of possible solutions in the design process.

It is important to state that several notable architects have used building bricks. The modernists Frank Lloyd Wright, Le Corbusier and Buckminster Fuller went through experiences using those bricks in their academic formation [9]. More recently, the BIG architecture office (Bjarke Ingels Group) has designed the LEGO Towers and the LEGO House. Also, the Greek architect settled in Brazil, Demetre Anastassakis, has an extensive work in projects of social interest houses making use of the bricking blocks during design process.

Thus, either in an academic environment or even in a professional one, building bricks can be considered instruments that aim to stimulate creativity. Regarding the specific scope of education, those instruments may contribute mainly during the initial period of architect's formation, in which the base concepts are located, helping them to understand in a clearer way the design process.

As reported by Sobreira [10], in architecture schools, "creation tools that explore the direct way from cognition to material idea must be encouraged: sketches and physical models". In this context, building bricks might be treated as a powerful didactic tool.

However, when it comes to building bricks toys designed specifically for the architectural universe, the same variety does not occur. Among that existing type of toys, one that must be highlighted are LEGO Architecture Studio, a box of 1,210 pieces with which a great variety of 3D models can be assembled. Another one available is Arckit—object of analysis of this

article, which, since its development in 2014, represents a design tool adopted by schools and universities.

4. Materials and Methods

This article is a product from both a literature review and an empirical research about the use of building bricks in the scope of formal conception of architecture design in a teaching-learning context. More specifically, it is a critical analysis about Arckit application to point out its limitations and possibilities.

It must be emphasized that this Arckit research belongs to a bigger research scenario, developed since 2014 at the Laboratory of Studies and Languages and Expressions of Architecture, Urbanism and Design, linked to Design, Representation and Technology Department from the Architecture School of Federal University of Juiz de Fora, which investigated the use of 10 different building bricks toys: (1) Tegu; (2) LEGO Architecture Studio; (3) Multiblocks; (4) Material dourado; (5) Playmags; (6) Montatudo; (7) Brincando de Engenheiro; (8) Pinosmágicos; (9) Jenga; and (10) Arckit.

The specific empirical research on Arckit was carried out from the observations made in a workshop with students from early years of the architecture and urbanism course, held in the first semester of 2017. Methodologically, the workshop was structured so that students could develop their free theme project, taking into account only the limits and possibilities arising from the grammar of the form of the game in use.

It is also worth noting that it was a manipulating form exercise, seeking a plastic-formal solution for a design to be developed. The workshop was guided by an exploratory and playful experimentation, dissociating itself from gestures that prioritize functional aspects rather than formal ones.

The version of Arckitbuilding bricks used during the workshop was the "A60", consisting 220 pieces, all in white or transparent plastic.

For the evaluation of Arckit utilization in the design

process, in order to observe the possibilities and limitations of this set of bricks, two major categories of analysis were pre-established: (1) formal language of the block game; and (2) its usability. The first category of analysis was divided into the following subcategories: (1.1) parts format; (1.2) types of connection; (1.3) material; (1.4) vocabulary; and (1.5) formal grammar. The second category comprises the following subcategories: (2.1) ease of assembling and disassembling; (2.2) execution time; (2.3) need for specific manual skills to play; and (2.4) usage restrictions.

These analytical categories were used for observations and evaluations of Arckit as a didactic material. The main results achieved in the workshop were critically incorporated into the database about possibilities of use of building bricks in design process, as well as other conclusions related to games above-mentioned.

5. Arckitbuilding Bricks

Arckit's manufacturing company describes it as a free-form architectural modeling system developed by Damien Murtagh, which allows designing and representing architecture physically. Through these building bricks, it is possible to develop ideas and present to teachers or clients quickly, in a reusable and economic way [11].

Arckit building bricks are available in different versions and models, and some of them have been designed for children. An instruction manual is included and there is the possibility of exploring a

virtual library as well, where there are textures to place on pieces. There are also, on Arckit's website, instructions about purchasing virtual models for SketchUp software.

Arckit brings different types of monochrome pieces with planned connections, with predetermined functions: there are pieces representing walls, roof structures, doors and windows, floors and stairs. In other words, Arckit has its own formal grammar.

Elaborated mainly for architecture, its pieces consist in modules in 1:48 scale. That system allows the design and preliminary design studies—although finished models can also be assembled—due to the level of detail of pieces, which give a final presentation aspect.

In addition to specific architecture pieces, more recently a kit for urban planning was also launched, titled “Master Plan”. As it turns out, Arckit's originality relates to its focus on all areas that involves the field of architecture and urbanism.

6. Designing with Arckit: The Art Gallery Case

Among the projects developed during the workshop, one that stood out was the case of the art gallery, assembled using 60 pieces of Arckit pieces. The architectural brief included the creation of a double height-foot space subdivided by a mezzanine dedicated to the exhibition of the collection and the sale of works of art, owned by a collector (Fig. 1).

The plastic-formal solution took into account the grammar of the shape of pieces available in Arckit A60 version, basically composed by rectangular pieces. The



Fig. 1 Project realized with the set of Arckit building bricks (designed by Icaro Chagas da Silva).

final result of the model also came from the amount of pieces available in this version. Thus, a prismatic volume was generated from the extrusion of a plant in L format.

After manipulating and constructing the model, once it was solved in a 3D physical point of view, complementary sketches were realized: floor plans and virtual model for the exercise of textures application on façades and simulation of the external environment.

Arckit design world and language had a direct interference on model's result. It should be noted that the existence of transparent parts led to the adoption of large glass planes located in facades, enriching natural light presence. Pieces' scale has strongly influenced the final volumetric model, which led to the design of an upright building, with high ceilings.

For the art gallery project, instructions manual's residence model was used. As long as the main purpose of using blocks is to develop user's creativity and design perception, structural or resistance calculus were not taken into consideration

7. Discussion

As can be concluded through the literature review, the use of building bricks in education refers initially to the first half of the 19th century, when the titled Fröebel Gifts were created. Currently, we find several pedagogical games, which are used for both entertainment and educational purposes. It is a learning-playing.

In architecture and urbanism education scenario, some experiments have been practiced by using LEGO or LEGO Architecture Studio, more recently adopted. With these games, students can exercise architecture design by creating easily assembled and disassembled three-dimensional models.

Arckit is inserted in that scenario. During observations made at the workshop and from all analysis performed after the result, some considerations can be established regarding the formal language of this game and its usability characteristics.

These characteristics are directly related to the possibilities and limitations of the use of the game in the context of architecture design.

Considering pieces' forms, Arckit A60 version has a collection able to represent walls, floors, stairs and roofs, as well as doors and windows. In a certain way, pieces' forms already indicate the possible formal solutions as a final result, since Arckit can be understood as a design world.

Pieces of this set of building bricks are connected by a "tongue and groove" system, also called "click and connect". At the ends of some parts, there are small pins for the socket, while in other parts there are holes. These fittings allow for a wide variety of formal and orthogonal plan creation. The precision of the inserts guarantees a good stability of the final model.

The material used in Arckit parts' manufacture is plastic. Most of the pieces are white and opaque, but there are transparent pieces that contribute to glass planes' representation. The lack of color guarantees greater freedom for the composition. Textures printed on stickers can be applied on the finished model.

Arckit's vocabulary consists of modular pieces, designed from a 1:48 scale grid. The pieces are based on basic shapes such as squares, rectangles, triangles and a quarter of circle. With these juxtaposed pieces, a great variety of architectural forms can be composed. Thus, it is possible to verify, even with a limited repertoire of parts, the generation of a wide range of solutions. Therefore, Arckit's formal grammar consists of both the pieces and the joining rules, provided by juxtaposition or overlapping joints.

The execution time of the model is relative and varies according to each project in construction. Yet, the time invested in assembling a model using pieces of this set is much shorter than the time spent with the making of a conventional craft model.

Certainly, the game is very intuitive, has few restrictions of use that relate to the limited number of pieces and does not demand any specific manual skill. It is understood that, by the time that users frequently

assemble three-dimensional models, they become more adept at playing.

Through all these aspects, there are several possibilities of application of building bricks in architectural design process. An important advantage of Arckit building bricks is the quick assembly and disassembly.

As one of the limitations, it is necessary to mention the repertory of forms, which is already conditioned to the set of given pieces. This limitation is analogous to the limitations found in designs using prefabricated parts. The logic underlying the grammar of form must be understood so that users can find functionally coherent and formally interesting solutions.

8. Conclusion

Composed of languages, most of which are attractive and capable of reproducing reality, building bricks in general are an increasingly influent in education as a didactic tool. Used often to foment student' interest, their ludic aspects contribute to logical and rational development, as well as to a better spatial understanding.

Building bricks' appropriation in architecture field increases the range of possibilities of experimentation and representation, helping future architects in their process of exploring formal solutions and apprehending spatial relationships through the construction of models and three-dimensional models.

From the studies accomplished during this research, it is verified that, knowing potentialities and limitations of Arckit building bricks, it can be explored during design process from volumetric models. As well as other building bricks games in market, Arckit can contribute to the development of creativity. It can still contribute to the entire design process, starting from the conception phase, through the representation, to the final presentation.

Acknowledgments

This work was supported by Fundação de Amparo à Pesquisa do Estado de Minas Gerais (FAPEMIGFundation)—Processes TEC APQ 01041/14 and TEC PPM 00766/15. This publication was made possible with financial resources of the EditalFadep—01/2017 (Support and Development Foundation for Teaching, Research and Extension of the Federal University of Juiz de Fora).

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