

EDUCATIONAL ANIMATION DEVELOPMENT AS SUPPORT TO CIVIL CONSTRUCTION WORKERS BASED ON THE LEAN PHILOSOPHY

Leiliane Santana Souza and Antônio Edésio Jungles*

Universidade Federal De Santa Catarina.

Article Received on 03/01/2019

Article Revised on 24/01/2019

Article Accepted on 15/02/2019

***Corresponding Author**

**Leiliane Santana Souza &
Antônio Edésio Jungles**

Universidade Federal De
Santa Catarina.

ABSTRACT

The use of resources making the modelling of the information possible has been increasing within the communication and education area. Animation is an example of multimedia solution used for learning. The goal of the present research is to develop educational animation for the staff involved in the work, making use of the lean

construction conceptual base. The secondary goal is the development of an application, aiming to store the educational animation as proposed. In order to reach the expected objectives, a research was carried out in Civil Construction Teaching Institutions in five different states, based on the Design Science Research, developed in 5 phases. Instrumentation and data collection addressed the target audience and designers/developers searching evaluation, at first, the target public concerning knowledge/identification with the educational animation, within a second stage, it assessed the educational animation and the application developed. The review of literature pointed out that contemporary languages used in education motivate, involve, and aid learner's memorization, although few researches deepen within the subject. The present study is expected to contribute to similar areas, as well as to investigate through debates and correlated follow-ups.

KEYWORDS: Educational animation, construction workers, lean construction, civil construction, management.

1. INTRODUCTION

Brazil needs to move forward, considering a mismatch between the presented education and the technological demands (FIESC 2017). Nowadays, technological means have been progressing concerning the transfer of knowledge, besides adding value to communication. In that context, the contemporary languages for education have been making use of resources with diverse media aiding the teaching/learning process, including animation.

In civil construction, for sometime, there has been a rising need of knowledge recycling, pushing the rising search for training course in schools, entities, unions, partners at the construction industry, and even at the building site. Nevertheless, what seems to be shown is that many times there is a gap between knowledge and the job information, making it difficult for the learning process.

Chiavenato (2010) believes the educational problem is one of the main responsible for the income concentration alerts to the crescent demand for more complete and qualified workers, and ends the argument stating that the unemployment rates are lower where the educational levels are higher.

Despite the efforts to overcome the lack of quality in professional qualification, it is still considered insufficient, in analyzing the gap in the quality of the available worker, in relation to what would be considered ideal for a greater sectoral development (ABRAMAT, 2007).

Brandenburg and Byrom (2006) argue that construction companies investing in human resource management strategies have achieved high levels of performance including high productivity, cost efficiency and overall company effectiveness.

Oliveira (2010) presents reasons for investing in training, such as: increasing the employee commitment to work and to the company, reducing accidents at the construction site, increasing incomes and the quality of the services, and company survival capacities, and others.

The Brazilian Program of Habitat Quality and Productivity - PBQP-H (2008) emphasizes the relevant social role of civil construction for its ability to reduce the housing deficit and agrees with the authors' view saying that the workforce training potentiates the generation of employment and income. It reinforces its argument by pointing to the call on the public

sector, articulating the entities, actions and training programs, and professional requalification, taking into account the specific needs of civil construction.

The acknowledgement of the importance of professional qualification is one of the focuses addressed by the Lean philosophy thinking. The success of the management system is among other factors related to the qualification and valuation of the employee at work (KOSKELA, 1992; SPEARS e BOWEN, 1999; POZZOBON *et al.*, 2004; LIKER, 2005; MAY, 2007).

The understanding of the need to invest in human resources training goes beyond the construction industry sector, covering several segments and it is a proven benefit to all involved.

Informal learning is a development on the subject, and has been discussed in correlated research. Schulz and Rosnagel (2009) state that there is a growing interest in the subject in the workplace. The authors assert that within the cognitive psychology, informal learning can be seen as intentional or unintentional, the latter being characterized in case workers do not realize the learning behind the planned action.

It is possible that reducing the pressure load on the learning process makes informal learning a lighter, and more relaxed option compared to the traditional method. The new forms of presentation support informal learning and therefore require attention and care.

In that sense, Portugal (2014) affirms that it is fundamental to search for new models, methods and approaches capable of including contemporary languages in teaching, among them: multimedia, hypertext, audio, video, animation, among others providing meaningful information and creating pleasant experiences in the teaching/learning process.

The relevance of the research goes beyond the competitiveness and success of the company management system, it is possible that the greatest contribution is based on the development of educational animation according to the needs of the workforce and the basis of lean construction, to assist the process. Hopefully, the use of contemporary languages can make it more attractive and then motivate the learner.

Holland (2003), believes that audiovisual resources can be considered as a type of didactic communication process. According to the author, the objective is to use the resources as

complementary to facilitate the assimilation of the content, since those can activate the human senses in the aid of learning.

Lowe and Boucheix (2008) argue that evidence shows the dynamic aspect of the animations can contribute to a more attractive effect for learning.

Ploetzner and Lowe (2012) ensure that animations are increasingly applied in education intending to improve student understanding in both abstract processes and concepts involving change over space and time.

It can be affirmed that, the carried out research brings to the construction workers some motivation to invest in the developed product, such as: a greater transparency of the processes, time optimization in the accomplishment of the services; the partial understanding of the constructive process and as a whole; the reduction of rework and even, the aid on decision making, since the previous reproduction of the work environment can be presented in the animation.

More broadly, we can also mention: the incentive to improve communication at the site; reducing the risk of accidents; increased productivity; the greater autonomy of workers in the performance of their tasks; the quality of services, among other benefits.

2. Educational Animation

The animation can be described as the art of capturing a series of individual and continuous positions that, once played in a quick sequence, conveys the movement illusion. It can be used as educational material, contributing to the educational process (PATMORE, 2003).

Animations can empower, facilitate, and engage the learner in learning situations (Ainsworth, 2008).

Para Patmore (2003) animation is the art of capturing a series of individual and continuous positions that, once played in a quick sequence, conveys the movement illusion. It consists of elements of syntax similar to those present in any other type of pictorial representation, painting, and visual information. For such reason, the analysis of graphical elements derived from heuristics, and guidelines of information design, and scientific visualization may enable new tools for the creation of educational material, contributing to the educational process.

Vygotsky (2001) states that cognition originates in motivation, but according to the author, it is not born spontaneously, it needs stimulation.

In such context, Gondim et al. (2011) state that the use of animation stimulates cognitive processes, such as perception, memory, language, thought, and others, as well as producing a playful environment for the learning development.

The authors state that animation enables the modeling of real events that temporarily evolve into abstract concepts. They draw attention to the interaction between user and system, achieved through the use of animation, since it is culturally perceived as a little formal language.

Huhnt et al. (2010) believe that the basic mission of animation is to transmit the knowledge in such a way that the learner can use the teaching, where the application was foreseen.

Xiangyu et al. (2013) reveal that animation is one of the media options used to produce Augmented Reality (AR). Although it is not the focus of this study, it is important to emphasize that discussions about the use of Virtual Reality (VR) in built environments have been increasing in researches in the field of architecture, engineering, construction, and such to help with issues such as planning, project, security, and risk operations training, and others.

It is important to mention characteristics that differ from the commercial animation of the animation developed within the educational approach. Lowe et al. (2008) affirm that the animation consists of forms or elements that change with respect to time in a sequential and continuous way.

Barbosa Júnior (2005) describes animation as art depending on technology and then, rely on resources of visual syntax, as well as drawing, and painting, but that aggregates audiovisual elements and, therefore, becomes a multimedia art that has the ability to tell stories and convey information.

Gondim, Nunes and Gonçalves (2011) affirm that the use of animation stimulates cognitive processes, such as perception, memory, language, thought, and others. It produces a playful environment for class development and also enables the modeling of real events which temporarily evolve into abstract concepts.

For Clark and Lyons (2010), each area sees the animation from a different perspective resulting in a set of diverse knowledge required for its design.

Mayer (2007) presents the TCAM (Cognitive Theory of Multimedia Learning) providing learning through multimedia, supplying animation construction instructions based on the information cognitive and perceptual question. Clark and Lyons (2010) also address cognitive, perceptual, visual factors, along with an analysis of the content nature to be turned into animation.

Filatro (2008) states that animation can be thought of as a learning object, which requires a series of contextualized actions for such production and focuses on the issue of meaningful and contextualized learning.

Alves (2017) contributes to the discussion by stating that animation has become a complex object requiring different knowledge and encompassing various contexts. Then, according to the author, a professional or even a single area of knowledge is not able to control the areas such material could potentially achieve.

3. Educational Animation Development for civil construction

Researches indicate that educational activities work as teaching help. As static images, the latter aggregate visual contents and interfaces with the advantages of time and movement setting and remain attractive, as well as having diverse elements such as sound, visual, and verbal language that can be set (LOWE, SCHNOTZ, 2008; AINSWORTH, 2008).

Learning depends on the perception, the understanding of the interface and information, as well as on cognitive, social and cultural factors. Busarello et al. (2013) contributes to the discussion by drawing attention to the understanding of media as knowledge source, also as an object of study and a form of expression to qualify education, from a critical, creative and responsible perspective.

Still as for the necessity of thinking about the media development, more precisely of the animation, focus of this inquiry, Alves and Battaiolla (2014) show that in view of the exposed, while focusing the content developed for such end, very often these objects do not consider the reception, interpretation, interaction, and assimilation of the content by the learners, in other words, do not take into account that this project can be thought on basis of that of studies in information design.

From the discussion above, the following item concerns the multimedia environments and the importance of its understanding for the animation development.

3.1. Multimedia environment contribution

Busarello and Ulbricht (2014) affirm that the current media consumption in the knowledge society is representative, significant, and justifiable by the emergence of media multiplatform that have been thought, rethought, and inserted in different scenarios, among which education. In such context, the EAD stands out, as it is appropriate to the characteristics desired to accommodate the current trends for education.

According to the studies of Portugal (2014) for the development of a hypermedia didactic material entitled Design, Education, and Technology, it is important to consider some issues for the development of similar projects. The author points out four themes and sub-themes for educational hypermedia project orientations, namely: information design, interaction design, didactic concepts and hypermedia design.

It is also important to conceptualize the term hypermedia, since it frequently appears in the assessed research. Gosciola (2004) claims to be "the set of means that allows simultaneous access to texts, images, and sounds in an interactive and non-linear way, making it possible to link media elements, control navigation itself, and even extract texts, images, and sounds sequence from which a personal version will be developed by the user".

For Portugal (2014), multimedia is a tool capable of exploring the senses of sight, hearing, and touch, which enables the presentation of information in an effective and meaningful way. He adds that "in view of this context, greater attention is drawn to studies that have found that people remember 15% of what they listen to, 25% of what they see and 60% of what they interact with".

Portugal (2013) states that, considering the educational aspects, video is a medium that can enhance teaching by its intrinsic characteristic of attracting attention and transmitting impressions. Complete reasoning by ensuring that it is exceptionally appropriate for teaching interpersonal skills, for the ability to show people in interaction.

Moore and Kearsley (2007) state that the video can show the sequence of actions involved, which can explore 'closes', slow or accelerated movement, and diverse perspectives.

The understanding of hypermedia design is quite relevant at this time, by the connection with the addressed theme, educational animation development for the construction workers. Alcoforado and Padilha (2011) add to the thinking, believing in the similarity between the process of building animation and the process of making films/videos. Although not definite, several authors agree that there are the following phases: (1) pre-production, (2) production, and (3) post-production.

Then, the review of literature presents similar points between the video making and animation. Corroborating the discussion, Alves and Battaiola (2014) affirm that knowing syntax models can help in the construction of animated information, as well as aggregate values already used in the static environment. For the authors, those assumptions do not function exactly as a method, but as a model composed of points of reflection that aid the animation design, both in the analysis and throughout its improvement process, pointing out suitable ways of realizing such design.

Alcoforado and Padilha (2011), when referring to the educational aspects of animation, affirm that there are a multitude of techniques that can be used in the classroom with students, but it is important to note that not all have the necessary knowledge to use such resources. Then, it is recommended that simpler techniques to be used, which do not require the use of advanced technological resources, since the main objective is not the technology itself, but its use as a facilitator of teaching/learning.

Alves (2012) explains that the production of commercial animations counts on specialized professionals for each aspect of the production (narrative, script, illustration, animation), however, this fact does not always happen with the development teams of educational animations.

The author warns that in many cases, in the design of educational animations, decisions are focused on the content presentation, based on the subjective knowledge and experience of the author responsible for the project (animator, teacher or animation and editing team). In this way, the process becomes variable and dependable on the repertoires of the developers, and they are not always able to do so.

Barbosa Júnior (2005) points out, in brief, four phases for the generation of commercial animations: 1) conception and development; 2) pre-production; 3) production, and 4) post-

production. The first and second phases of the process are characterized by the development of the story to be told. Then, history, requirements, goals, and graphic choices are set at that time. The third, and fourth are responsible for the execution of the planned decisions, the production.

It is important to mention that this research focuses on the first phase of the animation production process. This phase is responsible for the decisions guiding the rest of the process. Then it is important to study the elements of the script for the design process.

Clark and Lyons (2011) believe that learning occurs when new content is processed by working memory and then integrated into the learner's long-term memory.

Alves (2017) emphasizes the importance of the information organization and the use of narrative structures for learning. The author completes the argument stating that in learning the use of narrative can aid in memorization and empathy with the taught content.

The narrative describes building structures that characterize it and can assist developers in their design process. The studies related to discourse or narrative analysis were founded by several researchers who generated significant contributions to the area, the authors investigated elements and similar forms or categories of elements and forms that are found in the narratives.

Alves (2017) performs in his review the selection of elements of the script, commonly found in correlated researches. Those are: theme, subject, message, space, time, action, structure, character, scene, cohesion and narrator.

The author reorganizes in her research the elements presented in four modules, the first one dedicated to outlining the profile of the target audience. The other three modules form the elements that contribute to their script, they are: constructing of the narrative, structuring elements for the construction of the narrative, and element style for the narrative construction.

Alves (2017) draws attention to the current linear model proposed for the construction of animations, since this is limited to the conception of information as a merely technical construction or, as a playful and even childlike construction not directed to the expectations

of the target audience. However, the author states that this will depend on who and how the animation is conducted.

The model proposed by Alves (2017) sought to use participatory, collaborative and human-centered design as the basis for the design of educational animations, characterized by a systemic and integrated view of the problem and the educational design in which the highest goal will always be student learning.

The author emphasizes that, within the context, the designer creates the educational animation not only by the angle of the commercial animation production, but, understands its activity as something culturally and socially relevant, which encompasses ethics for its conception.

4. Method and Analysis of Cases

The use of knowledge in order to design/construct objects/artifacts for problem solving has been a concern of engineering (GOUVÊA DA COSTA; PINHEIRO DE LIMA, 2011).

Simon (1996), reinforces the argument by stating that the research objectives, such as the design of artifacts with desired properties, has been the goal of engineering schools.

Lacerda et al. (2013), affirms that the relevance of the produced knowledge and the tension in the theory-practice interface require a new focus in the research, which according to the authors, are research directed to the proposed project and that, in this way, better solutions to existing problems.

The carried-out research chose the use of the Design Science Research method, since it is prescriptive. Then, knowledge is intended to provide an instruction, or hold a recommendation, since it explains or suggests how to act.

For Vaishnavi and Kuechler (2009) the studied method can be described as a set of analytical techniques that enables the research development in several areas, particularly, in engineering.

The Design Science/Design Science Research has matured as an approach, mainly in the Technology and Information Management area (TREMBLAY; HEVNER; BERNEDT, 2010).

The correlated literature concerning the studied method presents different approaches to study performance using Design Science Research, however, they all have a scheme that briefly defines a phase where the problem is identified, another where solutions are proposed and developed, and finally to the evaluation of the proposal, so that the process can be completed.

4.1. Research Steps

The Design Science Research method has developed in five distinct phases. The first phase, the awareness, concerning the research delimitation and the awareness of the problem, followed by the choice of the participating institutions. It is important to point out that the review of literature came along with that particular phase, aiding to the necessary theory for the foundation of the research.

The second phase, the suggestion, consists in the elaboration of the questionnaire and later in its application. At this moment, possible solutions were risen to reach the proposed research goal. Step 1 of data collection has become important here to understand the target audience and their desires, as well as to explore possibilities related to the approach of contemporary languages in teaching/learning, especially with regard to educational animation. Data analysis was then carried out to bring relevant information to the next phase. The review of literature of correlated themes helped the selection of the reference model used to construe the proposed objective.

The third phase, the development, took place after the data analysis concerning the intended target audience, and also after the use of the reference model for the design of the educational animation. The cross reference of the information mentioned above and the conceptual basis of the lean construction, already summarized in the booklet of the lean construction, worked as a subsidy for the achievement of the main goal of this research, which proposes the development of a model of educational animation design for construction workers based on the lean construction. The execution of the second objective, the platform to keep the elaborated animations within the proposed model, and getting help at this research phase.

The evaluation takes part in the fourth phase, in which the proposed model is assessed by the target audience, and also by the developers, the designers. Then, step 2 of data collection, occurs with the elaboration of the questionnaire, and later, its application to the target

audience and to the designers. It is noteworthy that two types of questionnaires were developed, since there are two different groups for evaluation of the proposed model.

The fifth and final phase of the research is defined as completion, since the final evaluations have already been carried out to suggest improvements or to add important information that can be used by research on correlated topics.

4.2. Cases

The identities of the participating institutions involved in the research are mentioned, since none of them objected to the exposition. It is important to emphasize that no data that reveals the organizational structure will be revealed, since the questionnaires were applied with the objective of collecting information regarding the studied subject only, educational animation. Basically, the collections took place in two different institutions: Senai and the Instituto da Construção (Construction Institute). Five states took part in step 1 of the research: Santa Catarina, Amazonas, Espírito Santo, Rio Grande do Norte, and Piauí. Step 2 was restricted to the state of Santa Catarina.

An individual analysis is performed for each educational institution, by using the selected data in the time of the research. Basically, the information collected expressed the knowledge, relevance, and openness of the targeted audience, and contemporary languages, but specifically, educational animation. At the last moment of the collection, in step 2, the goal was the evaluation of the proposed design model, developed by this research, then, the structuring of the script was evaluated. Finally, a general analysis of the results is presented, from the charts and comparative tables of the participating research institutions.

The dynamics proposed for the application of the questionnaire to the target public can be described in two moments, shortly after the research, and the researcher presentation, in each institution part of the process, in this stage of data collection.

The first moment is characterized by the presentation of the video chosen among the available media, towards construction workers, available on the social network known as YouTube. The choice of the video Safety at Work - Falls, relied on the availability in social media, by targeting the same target audience, by relevant content in the area and because it was produced by the Brazilian Chamber of Construction Industry - CBIC with the support of

the Social Service of the Industry - SESI to help and motivate workers to keep their eyes on construction safety.

The second moment is characterized by the delivery of the questionnaire to the interviewees and their completion with the chosen alternatives, based on the watched animation. At the end of this stage, the questionnaires were collected for evaluation. Whenever possible, the photographic record was carried out in the physical space of the institution.

It is worth noting that, in the other states that took part in the study, the procedures for collection remained unchanged, since this was a recommendation of the researcher to the professionals in charge of the data collection within this study stage. As for the professionals who assisted through the data collection, it was a group composed of colleagues, all graduated in civil engineering, holding masters and/or doctorate in the area.

Table 1: Below, summarizes the general characteristics of the institutions taking part in the research.

Sample	City/ interviewees	Age	Academic background
1. Santa Catarina Construction Institute	18 interviewees Florianópolis Predominantly males (1 female)	18 to 56 years of age	Practically 50% of the sample hold high school level. (both complete and incomplete)
2. Amazonas SENAI/AM	11 interviewees Parintins Male	16 to 46 years of age	Practically 85% of the sample hold high school level
3. Piauí SENAI/PI	16 interviewees Teresina Predominantly males (4 females)	16 to 27 years of age	100% of the sample hold incomplete high school level
4. Espírito Santo Construction Institute	09 interviewees Vitória Predominantly males (2 females)	27 to 37 years of age	Practically 70% of the sample hold complete high school level
5. Rio G. do Norte SENAI/RN	15 interviewees Natal Male	18 to 21 years of age	Practically 50% of the sample hold high school level. (both complete and incomplete).

4.3. Data Collection Instruments

The questions of the collection instrument, and the applied questionnaire are justified by the fact that all of them are related, in one way or another, to the addressed topic: educational animation. Then, in stage 1, the questions related to the understanding of the theme, educational animation, as well as its involvement with the target audience and how much is possible the understanding of teaching/learning with this medium of presentation of the information.

In step 2, questions were directed not only to the construction workers, but also to the designers/developers, in order to evaluate the proposed design.

The application of the questionnaires was the means used to collect the data needed for the research. All carried out by researchers in the civil construction area, in the states in which they lived, at the time of the research. The data collections carried out in Santa Catarina, in stage 1, and 2, were applied by the researcher herself.

Next, the step questionnaire is presented into three distinct parts, concerning the related themes to the profile of the interviewees, animation and education, presented content, and the use of mobile applications are discussed, according to Table 2 as follows.

Table 2: Questionnaire – Step 1 (source: the author).




Part 1 - Interviewee Profile	
Questions	Answers
1.Age	A:
2.Academic Background	a) <input type="checkbox"/> 6th to 9th grade incomplete b) <input type="checkbox"/> Primary School Complete c) <input type="checkbox"/> High School Complete d) <input type="checkbox"/> High School Incomplete e) <input type="checkbox"/> Higher Education Complete f) <input type="checkbox"/> Higher Education Incomplete
3.Gender	a) <input type="checkbox"/> Male b) <input type="checkbox"/> Female
Part 2 - About Animation And Education	
4. Do you watch animations at home?	a) <input type="checkbox"/> Yes b) <input type="checkbox"/> No Comment, if you wish:
5. How often do you watch animations?	a) <input type="checkbox"/> every day b) <input type="checkbox"/> a few times a week c) <input type="checkbox"/> I don't watch it
6. What kind of animation do you like?	a) <input type="checkbox"/> Comedy/ Humor b) <input type="checkbox"/> Romance c) <input type="checkbox"/> Action/adventure d) <input type="checkbox"/> Drama e) <input type="checkbox"/> Scientific fiction f) <input type="checkbox"/> Others. Which?
7. What do you like the most when watching animations?	a) <input type="checkbox"/> Scenery b) <input type="checkbox"/> Characters c) <input type="checkbox"/> Story d) <input type="checkbox"/> Possibility of controlling the animation e) <input type="checkbox"/> Jokes f) <input type="checkbox"/> New world fantasies g) <input type="checkbox"/> Impossible actions


	h) () Cartoon style i) () What else?
8. Have you ever watched an animation about Civil Construction?	a) () Yes b) () No What was it about?
9. Did you like to learn through animations?	a) () Yes b) () No Why?
Part 3 - Presented Content	
10. Did the presented content help you to better understand the subject: Occupational Safety?	a) () Not really (grade -1) b) () A little bit (grade -2) c) () In part (grade -3) d) () A lot (grade -4) e) () Definitely (grade -5)
11. Did the presented content make it clear the importance of using personal protective equipment (PPE)?	
12. Did the presented content rise the need of respecting safety rules, including respect to worksite signs?	
13. Did the presented content make it clear the importance of using collective protective equipment (CPE)?	
14. Would recommend the animation you have watched to a friend?	
Part 4 – About The Use of Apps on The Cell Phone	
15. Have you ever used APPS on the cell phone?	a) () Yes. b) () No Which?
16. What is your opinion on the use of cell phone APPS?	a) () I like using them b) () I don't like using them c) () I don't know how to use them
17. What would you do if you could use an APP to help you on the Civil Construction activities?	a) () I would accept it b) () I would refuse it c) () I would not know how to use it Comment, if you wish:

The dynamics of the questionnaire application in step 2 happened differently, since after the animation was presented, a time was set for answering the questionnaire. In total, there were 3 animations presented, each one, more than once, so that the interviewees could better understand what was presented on the scene. Also, in step 2, a specific part was specifically directed to the design/developers, the part 4 of the questionnaire. At that moment, questions were asked regarding the developed application, the 'apply lean'.

Next, the questionnaire in step 2 is presented, split into three distinct parts, concerning the themes related to: narrative construction, narrative elements, and style, and the application 'apply lean', as shown in Table 3 below.

Table 3: Questionnaire – Step 2 (source: the author).

Part 1 – Narrative Construction		
<p>Animation 1</p> 	1. Did the presented animation conveyed the main idea of the story: Perform the inspection of the materials, in order to help the company to always improve its services?	a) () Not really (grade -1) b) () A little bit (grade -2) c) () In part (grade -3) d) () A lot (grade -4) e) () Definitely (grade -5)
	2. Did the presented animation help to understand the importance of using materials under the specific patterns for each used material?	
	3. Did the story images on the presented animation help to bolster the importance of checking the materials to be used and if they are under the regular patterns?	
Part 2 – Narrative Elements		
<p>Animation 2</p> 	4. Did the presented animation make it clear who the main story character is: the civil construction worker?	a) () Not really (grade -1) b) () A little bit (grade -2) c) () In part (grade -3) d) () A lot (grade -4) e) () Definitely (grade -5)
	5. Was the presented animation clear to emphasize the need of being open to perform various services?	
	6. Did the presented animation show the basic movements of the character in performing the services: finishing, woodwork, and hydraulic services?	
Part 3 – Narrative Style		
<p>Animation 3</p> 	7. Did the presented animation show the scene performed by the character in a clear way: cement mortar production for a service.	a) () Not really (grade -1) b) () A little bit (grade -2) c) () In part (grade -3) d) () A lot (grade -4) e) () Definitely (grade -5)
	8. In the presented animation is it possible to identify the most important elements concerning the understanding of the scene: the main character (worksite worker) and the object he is using (cement mortar, and the trowel for the cement production)?	
Part 4 – APP – Apply Lean		
APP - Apply Lean	9. Is the presented APP ‘Apply Lean’ suggesting to construction workers the performance of good practices in the worksite?	a) () Not really (grade -1) b) () A little bit (grade -2) c) () In part (grade -3) d) () A lot (grade -4)
	10. Is the presented APP ‘Apply Lean’, taking the user to the main content in a quick and simple way, accessing home or the main menu?	

	<p>11. Is the presented APP ‘Apply Lean’ showing short texts, images, and animations that lead to a better understanding of the content: good practices tips for the Lean construction to be used by the worker every day at the worksite?</p>	<p>e) () Definitely (grade -5)</p>
---	--	-------------------------------------

4.4. General Analysis

4.4.1. Questionnaire / Step 1

Within the questionnaire applications in two stages, tables, and graphs were generated from the data collected in the institutions, and selected for the research. Table 4 below shows the percentage of responses obtained with the data collection from questionnaire 1, part 2 to 4.

Table 4: Percentual collection –Questionnaire/ Step 1 (source: the author).

Part 2							Part 3						
Question 4							Question 11						
	SC	ES	AM	PI	RN	MEAN		SC	ES	AM	PI	RN	MEAN
A	72%	100%	91%	88%	93%	89%	A	0%	0%	0%	0%	0%	0%
B	28%	0%	9%	13%	7%	11%	B	6%	0%	0%	0%	7%	2%
							C	0%	11%	0%	0%	7%	4%
Question 5							D	39%	22%	45%	56%	47%	42%
	SC	ES	AM	PI	RN	MEAN	E	56%	67%	55%	44%	40%	52%
A	0%	0%	18%	6%	7%	6%							
B	83%	33%	73%	81%	87%	71%	Question 12						
C	17%	67%	9%	13%	7%	22%		SC	ES	AM	PI	RN	MEAN
							A	0%	0%	0%	0%	0%	0%
Question 6							B	6%	0%	0%	6%	7%	4%
	SC	ES	AM	PI	RN	MEAN	C	0%	0%	9%	0%	7%	3%
A	44%	33%	45%	44%	40%	41%	D	33%	56%	36%	63%	53%	48%
B	0%	0%	0%	0%	0%	0%	E	61%	44%	55%	31%	33%	45%
C	44%	44%	55%	50%	40%	47%							
D	0%	0%	0%	0%	0%	0%	Question 13						
E	6%	22%	0%	6%	0%	7%		SC	ES	AM	PI	RN	MEAN
F	6%	0%	0%	0%	20%	5%	A	6%	0%	0%	0%	0%	1%
							B	6%	0%	0%	0%	13%	4%
Question 7							C	0%	0%	9%	19%	7%	7%
	SC	ES	AM	PI	RN	MEAN	D	22%	44%	36%	50%	47%	40%
A	17%	0%	0%	13%	0%	6%	E	67%	56%	55%	31%	33%	48%
B	11%	33%	27%	31%	20%	25%							
C	56%	44%	27%	13%	53%	39%	Question 14						
D	0%	0%	0%	0%	0%	0%		SC	ES	AM	PI	RN	MEAN
E	0%	0%	18%	0%	13%	6%	A	0%	0%	0%	0%	0%	0%

F	6%	11%	0%	13%	0%	6%
G	6%	11%	18%	13%	7%	11%
H	0%	0%	0%	19%	7%	5%
I	6%	0%	9%	0%	0%	3%
Question 8						
	SC	ES	AM	PI	RN	MEAN
A	44%	67%	64%	88%	67%	66%
B	56%	33%	36%	13%	33%	34%
Question 9						
	SC	ES	AM	PI	RN	MEAN
A	100%	100%	100%	100%	100%	100%
B	0%	0%	0%	0%	0%	0%
Part 3						
Question 10						
	SC	ES	AM	PI	RN	MEAN
A	0%	0%	0%	0%	0%	0%
B	6%	0%	9%	0%	7%	4%
C	22%	0%	18%	19%	20%	16%
D	33%	67%	27%	75%	47%	50%
E	39%	33%	45%	6%	27%	30%
B	0%	0%	0%	13%	0%	3%
C	11%	11%	0%	19%	0%	8%
D	22%	33%	9%	31%	13%	22%
E	67%	56%	91%	38%	87%	67%
Part 4						
Question 15						
	SC	ES	AM	PI	RN	MEAN
A	83%	78%	45%	88%	53%	69%
B	17%	22%	55%	13%	47%	31%
Question 16						
	SC	ES	AM	PI	RN	MEAN
A	89%	78%	55%	88%	87%	79%
B	11%	11%	27%	6%	13%	14%
C	0%	11%	18%	6%	0%	7%
Question 17						
	SC	ES	AM	PI	RN	MEAN
A	94%	89%	100%	100%	100%	97%
B	6%	11%	0%	0%	0%	3%

It is generally perceived that educational animation can be used as an auxiliary tool in the teaching/learning process, according to the analysis of the report on the data collection.

In the general state mean, 100% of the interviewees say they enjoyed learning from the animation and most of them affirm they have already seen animations focused on construction. Another finding is that most interviewees also watch animations or cartoons at home.

As for the favorite animation style as stated by the interviewees are comedy/humor, and action/adventure. Fiction and other possibilities discussed follow those, as the favorite ones.

Story and the possibility of controlling the situation are shown prominently, in analyzing what draws the attention of the interviewees when watching an animation. Impossible actions style follows up. In the last place are the scenario, the jokes, and the fantasies of new worlds.

It is confirmed that the use of the APP is already a commonplace in the day to day for most interviewees. It was also observed that most of the interviewees were open to the possibility

of using an Application able to assist them in activities, and content related to civil construction.

Most of the subjective responses in the questionnaire in step 1 showed interest in learning with animation. Among them, the following favorable arguments could be retrieved from it: "it's easier to understand", "animation is a safe form that hurts nobody", "it is more cheerful", among other answers.

4.4.2. Questionnaire/ Step 2

As a whole, the target audience was enthusiastic and interested in the subject in both steps of data collection, stage 1, and stage 2. The analysis of the individual reports showed that it could be influenced by the non-obligation of learning content at any given time.

While evaluating step 2, it was noticed that when the need to respect the safety conditions, and the respect to the sign in the worksite was addressed, the topics were clear in the presented video, according to the interviewees. The content presented also helped to clarify the importance of the use of Collective Protection Equipment (EPC).

In analyzing the construction of the narrative, most of the interviewees affirm that the presented animation has definitely helped a lot to the understanding of the subject: carrying out the material inspection, helping the company to improve its services constantly; clarifying the importance of using materials within the specific standards for each used material.

As for the images that appeared during the story, the interviewees affirm that those helped to reaffirm the importance of checking on the materials that are to be used and still if they are within the regular standards.

Regarding the narrative structure, most interviewees affirm they have definitely helped a lot, in understanding the content addressed: 'who is the main character of the story' - the construction worker, the need to be open to the accomplishment of various services, and the basic movements of the character when performing the services of finishing, woodwork, and hydraulic services.

In analyzing the narrative structure style, most interviewees affirm it has definitely helped a lot in understanding the content addressed: the scene performed by the character – mortar cement production for a service, and if it is possible to identify the most important elements

to the understanding of the scene: the main character (worker at the construction site) and the object that he is using (the wheel barrow for cement production). Figure 1 below presents the evaluation of the script elements, according to the target audience.

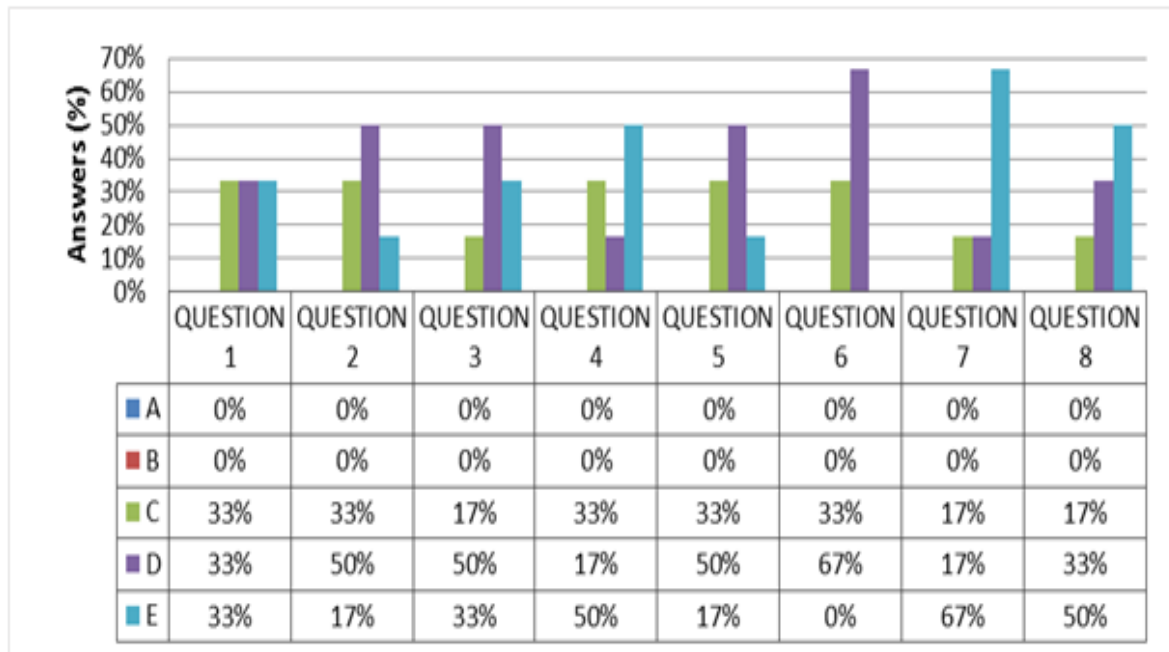


Figure 1: Script elements evaluation – target audience (source: the author).

The questions in part 4 of the questionnaire were evaluated only by the designers/developers, and are related to the Application Apply Lean. Figure 2 below presents the percentage of questionnaire responses applied to designers/developers.

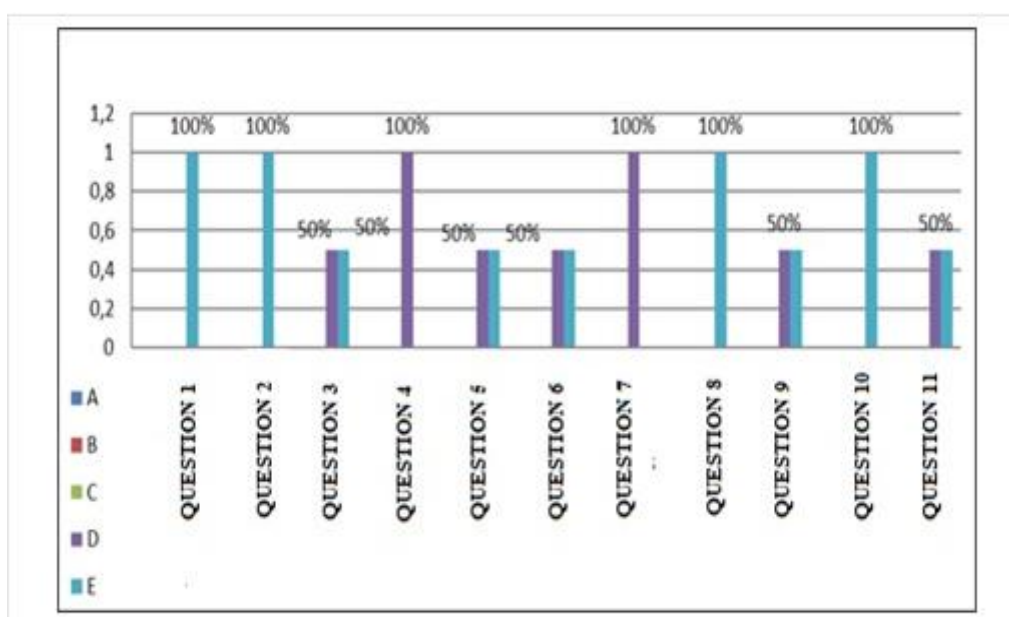


Figure 2: Performed approaches (source: the author).

As for the evaluation of the Application by the designers/developers, they claim the application Apply Lean definitely helped a lot in the retrieving of the main idea of the scene, the accomplishment of good practices in the construction site.

The designers/developers claim that the Application Apply Lean helps in leading the user to the main content quickly and simply by accessing the main menu.

Finally, the Application Apply Lean, according to designers/developers, interacts with short texts with images, and animations that help to better understand the content covered: lean good practice tips to be used by the construction worker in their day to day in the at the construction site.

5. Script for the design of educational animation for the civil construction

The understanding of the module structure of the reference model enables a greater fluidity for the design of the script, and finally, the development of the educational animation. As in the Alves model (2017), this research split into structure modules composing the script. Figure 3 below shows the scheme followed for the development of the educational animation design model towards the worker, in which the indicated numbering represents the delimitations of: 1) target audience; 2) narrative elements style; 3) narrative elements, and 4) construction or delimitation of the narrative

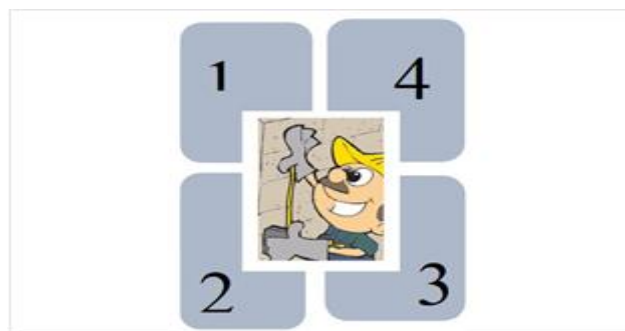


Figure 3: Script design modules (source: Adapted from Alves, 2017).

5.1. Target audience

The target audience set for this research determined the choice of the theme, the subject, the space, the action, characteristics and archetype, etc. Therefore, basic needs were taken into account in order to create the character, and the content to be presented.

The texts are basically short, the scenario is basic, there are no elements not being used in the scene or that are not part of the content to be transmitted.

The language is simple and colloquial. The movements are slow and discrete, but they help to realise what has been passed through the scene, emphasize what should be the main focus.

The character is a characterization of the construction site worker, from a simple drawing, but with striking expressions.

Module 1, shown in the figure above, has not been described in the reference module, since it can vary, depending on the direction. Thus, Table 5 below summarizes and highlights some of the points that appear in the description of the target public, according to the analysis of the data collection carried out in educational institutions focused on civil construction.

Table 5: Target audience (source: the author).

Target Audience	
Age	15 to 62 years
Gender	Predominantly male.
Favorite styles	Comedy, action, and scientific fiction.
Preference in watching animation	Scenery, character, story, fantasies of new worlds, and impossible actions.
Content	The principles of the Lean construction.
Language applied	Coloquial/informal.
Motivacional elements	External motivation – to know a little bit more of the work environment and the services and used tools. Internal motivation – desire to a greater satisfaction at work, self-esteem, suggestions to a better quality of life, leisure/pleasure.

The above description is fundamentally important in building a product that can achieve the real desires of the target audience. In this way, knowing the preferences, the motivations, the age group and limitations, among other things, it is possible to reach the proposed goals.

5.2. Narrative construction

For the narrative construction a presentation of the general view of the theme was necessary, including the space and the time where the scenes would happen. Then, Table 6, below, reports every necessary point for the narrative construction, describing the six elements for its definition. They are: theme, subject, message, space, time, and action.

Table 6: Narrative construction (source: Adapted from Alves, 2017).

Theme	Subject	Message
What is the story about?	How does the theme is shown and developed?	What is the conclusion one can retrieve from the story?
The story talks about the day-to-day routine of the worker in the construction site, and his daily actions.	At each scene, it is possible to focus on the worker's action, who consciously performs it (whether in the execution of a task, in the use of a work tool, in the exchange of experience with a colleague, among others).	It is possible to carry out actions focused on the principles of lean construction in day-to-day work.
Space	Time	Action
Where? (story place/environment)	What is the time of the action?	Structure of the actions and the events designing the scenes?
The scenery is a regular day in a civil construction site.	The story takes place nowadays. It corresponds to a working day.	The physical action will be expressed by the correct execution of each service, considering the studies of the ergonomics for the accomplishment of the tasks. The emotional action describes a positive character constantly motivated to learn.

5.3. Elements to the narrative construction

The element structure for the narrative construction was described as a set of forms or elements composing the script. Then, an event selection from the character's life was approached. Table 7, below, describes each point for structuring the elements for the construction of such narrative, describing the three elements for definition. They are: structure, character, and scenes.

Table 7: Elements for the narrative construction (source: Adapted from Alves (2017)).

Structure	
Definition Set of forms or elements composing the script, selection of events within the character's life story composed as a strategic sequency to stimulate specific emotions.	
Plot	How to use good practices to solve the day-to-day issues of the construction site using the basic principles of lean construction.
Drama	The worker is aware of his actions and seeks to perform good practices in the work environment.
Acts	The questioning as to the current action and the considered action satisfactory for a certain procedure.
Conflicts	What can I do to improve what I already do? What are the proved practices that I must follow?
Turning point	New knowledge to the performance of good practices.
Story development	The worker knows and performs what he learnt.

Climax	The worker feels satisfied by practicing the action/thought that made his work even better.
Side stories	The worker passes on to his colleagues the new knowledge.
Other developments (from the items)	The employee is recognized for his or her performance in the service or attitude that has contributed to the improvement of the processes in the workplace.
Character	
Definition: Acting or non-acting beings in the story, not necessarily humans.	
Roles	Miguelito – Construction site worker (Protagonist) Master builder (Supporting role) Colleague (Supporting role)
Function in the drama	The main character is actively performing the drama.
Kinds of characters	The main character is the caricature of a middle-aged workman.
Needs	The character wants to know the best way to perform the services that are assigned to him, as well as to know the most appropriate tools for performing them.
Characteristics	Medium height, sharp curves, mustache, and striking expressions.
Truth level	The scenes depict real day-to-day situations of the construction site, but do not stick to the representation of the complementary scenario, only what is necessary for the transmission of the story's main message.
Character motivation	The character is motivated by his daily learning because he understands that he is the first client of the process.
Evolution	There was no significant evolution in the actions of the main character.
Applied archetype structure	Middle-aged man with habits from a traditional education.
Conflicts	How to keep healthy relationships in the workplace. Finding ways to develop in the work environment.
Scenes	
Definition: An event in the story that presents the action with the conflict in a continuous time.	
Objects	The tools and the specific scene of each service, at the construction site.
Actions	What generates each action carried out in practice, day-to-day, at the construction site.
Speech design	The lines almost do not exist, the expressions depict the message that the character wants to transmit.
Texts and subtexts in the action	The texts portray the actions considered as good practices, to be performed at the construction site
Visual design	The scenario is simple. We chose to portray only what was necessary to convey the main message of the scene.
Size	The events are fast, under short time, as they portray the everyday routine and emphasize what is already done and leads to continuous improvements.
Plan and angle camera types	To be defined with the team

Signatures	To be defined with the team
Index	Use regular terms already used in the work environment (slang or regular words of the target audience)
Scene sequence	The scenes were divided according to the principle of the lean construction presented.
Drama scenes	Some scenes were exaggerated to draw the attention from the target audience.

5.4. Element styles within the narrative construction

The structuring of the element styles for the narrative construction was possible after the presentation of the writing form and elements that make the narrative attractive and also the presentation of the narrator, character responsible for telling the story. In the presented case, the main character is the construction worker.

Table 8, below, describes each point for structuring the style of the elements for the narrative construction, describing the two elements for definition. They are: cohesion and narrator.

Table 8: Element styles within the narrative construction (source: Adapted from Alves (2017)).

Cohesion	
Definition: Writing and element forms turning the narrative attractive.	
Anticipation of the outcome	Not present
Recurrent themes	The construction site scenario (fences, tools, building materials, signs, PPE, among others).
Repetition	Repetition of the main character using the uniform and needed tools for each service.
Contrasts	Some drawings were represented out of the usual pattern, in order to draw attention to the main message of the scene.
Unity	Repetitions in the scenarios promoted the unity of the parties.
Factors to success	The relaxed approach, short duration, and simple language have come together to convey the main message of the story.
Connection	The verisimilitude between the told story and the reality, bring the target audience closer to the developed product, creating empathy.
Clearness	Short phrases and images all focused on the representation of necessary objects from which the combination conveyed clearness to the scenes.
Narrator	
Definition: Character or being telling the story	
Type	Selective omniscient narrator (third person): narrates the facts always with the concern of reporting opinions, thoughts, and impressions from one or more characters.

6. Application Apply Lean

At the end of the process, an application was developed to store the educational animations developed for this research. The configuration of the application was made after considering the review of the literature and the proposed model for learning object development. Figure 4, below, shows the icon that appears in the application presentation.



Figure 4: Apps icons (source: the author).

In general, the application was designed to take Lean concepts into day-to-day civil construction and to help to apply Lean, Lean building principles to the work environment. The 11 principles of Lean construction were addressed sequentially, contemplating a brief explanation of each of them and presenting examples of Lean actions at the end.

7. CONCLUSIONS

With the popularization of technology as a teaching resource, there has been a need to develop solutions to meet the demand focusing on the use of contemporary languages for teaching/learning.

It is generally perceived that educational animation can be used as an auxiliary tool in the teaching/learning process, according to the analysis of the data collection reports.

In the general states average, 100% of the participants say they enjoyed learning from the use of animation and most of the interviewees affirm that they have already seen animation focused on construction. Another finding is that most interviewees already watch animations or cartoons at home.

As for the favorite animation style the interviewees showed interest in comedy/humor and action/adventure. The fiction and other possibilities covered appear next, as the favorite style of the interviewees.

The story and the possibility of controlling the situation are shown prominently, when analyzing what draws the attention of the interviewees when they are watching an animation. Impossible actions come next. In the last place in the preference are the scenarios, the jokes, and the fantasies of new worlds.

Most of the interviewees affirm that the questions addressed with the animated video (step 1 of the collection) helped a lot or definitely help in the understanding of the content approached and they would indicate the video to a friend.

Concerning the need to respect safety conditions and respect the signs at the working site, all made clear in the presented video, according to the interviewees. The presented content also helped to clarify the importance of the use of collective protection equipment (CPE).

When analyzing the narrative construction, most of the interviewees affirm that the animation definitely helped a lot to the understanding of the subject: to inspect the materials to help the company to always improve its services; clarify the importance of using materials within the specific standards for each material used.

In general, the target audience was enthusiastic and interested in the discussed subject, in both moments of data collection. Analysis of individual reports has shown that this may be influenced by the non-requirement to learn content at any given time. Most of the subjective responses in the questionnaire in step 1 were answered by demonstrating interest in learning with animations. Among them, the following favorable arguments could be presented: "it's easier to understand", "animation is a safe form hurts nobody", "it is more cheerful", among others.

Then, the animation is expressed as an interesting and attractive alternative, from the point of view of the interviewees, to assist in the teaching/learning process in civil construction.

REFERENCES

1. Ainsworth, S. How do animations influence learning? School of Psychology and Learning Sciences Research institute, University of Nottingham, University Park, Nottingham, UK, 2008.
2. Alcoforado, M. G.; Padilha, M. A. S. Educando com Design de Animação. Anais do 5º CIDI | Congresso Internacional de Design da Informação. Florianópolis: UFSC| Universidade Federal de Santa Catarina, 2011.

3. Alves, M. M. Design de animações educacionais: Modelo para a concepção colaborativa de animações educacionais para o Ensino Fundamental. Tese de Doutorado. PPGDesign, Curitiba: UFPR, 2017.
4. Alves, L. Gestão de pessoas em organizações empreendedoras: um estudo do Mapeamento de Competências Comportamentais. In: Lapolli, Édis Mafrá; Franzoni, Ana Maria B.; Souza, Vitória A.B. de. (Org.). Gestão de pessoas em organizações empreendedoras. Florianópolis: Pandion, 2012.
5. Alves, M. M. e Battaiola, A. L. Modelo de análise gráfica para animações educacionais. Anais do 5º CIDI | Congresso Internacional de Design da Informação. Florianópolis: UFSC| Universidade Federal de Santa Catarina, 2012.
6. Andery, M. A. et al. Para compreender a ciência: uma perspectiva histórica. Rio de Janeiro: Editora EDUC, 2004.
7. Anjos, T. P.; Gontijo, L. A. Recomendações de usabilidade e acessibilidade para interface de telefone celular visando o público idoso. *Production*, 2015; 25(4): 791-811.
8. Amaral, T. G. Metodologia de qualificação para trabalhadores da construção civil com base nos conhecimentos da Construção Enxuta. (Tese de Doutorado). Universidade Federal de Santa Catarina. Florianópolis, 2004.
9. Associação brasileira da indústria de materiais de construção (Abramat) Capacitação e Certificação Profissional na Construção Civil e Mecanismos de Mobilização da Demanda. Escola Politécnica da Universidade de São Paulo- Departamento de Engenharia de Construção de São Paulo. São Paulo, 2007.
10. Aziz, R. F.; Hafez, S. M. Applying lean thinking in construction and performance improvement. In: *Alexandria Engineering Journal*, Egypt, 2013.
11. Barbosa Júnior, A. L. Arte da Animação: técnicas estéticas através da história. 2. Ed. Senac: São Paulo, 2005.
12. Barreto, A.V. P.; Honorato, C. de F. Manual de sobrevivência na selva acadêmica. Rio de Janeiro: Objeto Direto, 1998.
13. Bayazit, N. Investigating Design: A Review of Forty Years of Design Research, Massachusetts Institute of Technology. *Design Issues*, 2004; 20(1): 16-29.
14. Bressiani, L. A utilização da andragogia em cursos de capacitação na construção civil. Tese (Doutorado em Engenharia Civil) – Universidade Federal de Santa Catarina, Florianópolis, 2016; 338.
15. Broad, M. L e Newstrom, J. W. Transfer of training: Action-Packed strategies to ensure high payoff from training investments. Reading, MA: Addison-Wesley, 1992.

16. Bogado, J. G. M. Análise da polivalência na construção civil por meio de treinamento por competências. Tese: Doutorado em Engenharia Civil (Construção Civil). UFSC, Florianópolis, 2010.
17. Busarello, R. I.; Bieging, P.; Ulbricht, V. R. Mídia e Educação: novos olhares para a aprendizagem sem fronteiras. Pimenta Cultural, 2013.
18. Burton, M.; Felker, D. Desenvolvimento de aplicativo para android para leigos. Alta Books: Rio de Janeiro, 2014.
19. Carvalho, A. V. Treinamento de recursos humanos. São Paulo: Pioneira, 1988.
20. Cardoso, F. F. Proposta de Modelo para certificação de empresas especializadas de execução de obras do PBQP-H. In: XI Encontro Nacional De Tecnologia DO Ambiente Construído. Anais, Florianópolis SC, 2006.
21. Cattani, A. Utilização de recursos da tecnologia da informação para a qualificação de trabalhadores da construção civil em leitura e interpretação de plantas. In: Ambiente Construído- Revista da Antac. Porto Alegre, 2003.
22. Chakrabarti, A. A course for teaching design research methodology. Artificial Intelligence for Engineering Design, Analysis and Manufacturing, 2010; 24: 317-334.
23. Chiavenato, I. Gestão de Pessoas. 7. ed. Campus – RJ, 2010.
24. Clark, R. C.; Lyons, C. Graphics for learning: proven guidelines for planning, designing and evaluating visuals in training materials. New Jersey: John Wiley & Sons, 2010.
25. Cruz, J. R., Ramos, R., Rodrigues, W. B. Guideline para desenvolvimento de aplicativos educacionais mobile. Workshop de Computação da Faccamp. Campinas/ São Paulo, 2015.
26. Cullen, K. Layout workbook: a real-world guide to building pages in graphic design. Rockport, 2005.
27. Cuperschmid, A.R.M; Grachet, M. Fabrício. M.M. Realidade Aumentada como Auxílio à Montagem de Parede em Wood-Frame. PARC Pesquisa em Arquitetura e Construção, Campinas, 2015; 6(4): 266-276.
28. Duarte Filho, N. F.; Barbosa, E. F. Estudo e Definição de um Conjunto de Características e Requisitos para Ambientes de Aprendizagem Móvel. 23º Simpósio Brasileiro de Informática na Educação, 2012.
29. Easterby-Smith, M., Thorpe, R; Lowe, A. Management Research: An Introduction. London: Sage Publications, 1991.
30. Farina, M. Psicodinâmica das cores em comunicação. 5. ed. São Paulo: Edgard. Blusher, 2000.

31. Feijó, V. C., Baldessar, M., e Vieira, M. L. Elementos de design para interface de Apps em smartphones: o iPhone 4S. XXI Simpósio de Geometria descritiva e desenho técnico, 2013.
32. Ferenhof, H. A; Fernandes, R.F,. Passos para construção da Revisão Sistemática e Bibliometria. V. 3.02 Disponível em: http://www.igci.com.br/artigos/passos_rsb.pdf Acesso em: junho/, 2016.
33. Federação Das Indústrias De Santa Catarina (FIESC). 4º Encontro da Associação Brasileira de Internet Industrial (ABII). Florianópolis, 2017. Disponível em: https://fiesc.com.br/noticia/investimentos-em-educacao-e-saude-ajudam-superar-desafios-da-industria-40?_ga=2.136281393.1614437717.1516882128-472335105.1507899588.
34. FILATRO, A. Design instrucional na pratica. Sao Paulo: Pearson Education do Brasil, 2008.
35. Fiorelli, J. O. Psicologia para administradores. São Paulo: Atlas, 2004.
36. Formoso, C. T.; Pellicer, E.; Yepes, V. Occupational safety and health in construction: some international experiences on education and training. In: International Technology, Education and Development Conference, Valencia, Espanha, 2011.
37. FREIRE, Ailton Soares. Proposta de um modelo de capacitação profissional para a construção civil utilizando o design instrucional: Capacitação do montador de sistema solar fotovoltaico. Tese (Doutorado em Engenharia Civil) – Universidade Federal de Santa Catarina, Florianopolis, 2016; 338.
38. Freire, Paulo. Pedagogia da autonomia. São Paulo: Paz e Terra, 1996.
39. Fujimoto, A. Treinamento e educação: Qualificação profissional da construção civil. 2005. Tese (Doutorado). Faculdade de Engenharia Civil, Universidade Estadual de Campinas. Campinas, 2005.
40. FLOR, Carla da Silva et al. A hipermídia como ferramenta de aprendizagem na sociedade do conhecimento. In: Anais do 4º Congresso Nacional de Ambientes Hipermídia para Aprendizagem (Conahpa), 2009; 1-11.
41. Fontoura, A. M. EdaDe: a educação de crianças e jovens através do design. Tese de Doutorado. Florianópolis: UFSC, 2002.
42. Florianópolis: UFSC, 2002.
43. GIL, Antônio C. Como elaborar projetos de pesquisa. 4 ed. São Paulo: Ed. Atlas, 2002.
44. Gosciola, Vicente. Roteiro para as novas mídias. Do game à TV interativa. São Paulo: Senac, 2003.

45. Gouvêa DA Costa, S. E.; Pinheiro DE Lima, E. Processos: Uma Abordagem da Engenharia para a Gestão de Operações. In: MIGUEL, P. A. C. et al. Metodologia de Pesquisa em Engenharia de Produção e Gestão de Operações. Rio de Janeiro: Campus, 2011; 4: 63-72.
46. Hirota, Ercília Hirota; Formoso, Carlos Torres. Implementação da Construção Enxuta: contribuições da aprendizagem na ação In: II Simpósio Brasileiro De Gestão Da Qualidade E Organização Do Trabalho No Ambiente Construído. Fortaleza, CE, 2001.
47. Heineck, L. F.M.; Rocha, F. E. M. da; Pereira, P. E.; Leite, M. O. Coletânea edificar lean – Construindo com o Lean Management, v.1.. Fortaleza, Expressão Gráfica Editora, 2009; 104.
48. Holanda, E.P.T. Novas tecnologias construtivas para produção de vedações verticais: Diretrizes para o treinamento da mão de obra. São Paulo, Dissertação (Mestrado em Engenharia). Escola Politécnica da Universidade de São Paulo. EPUSP/USP. São Paulo, 2003.
49. Huhnt, W., Richter, S., Wallner, S., Habashi, T., & Krämer, T. Data management for animation of construction processes. *Advanced Engineering Informatics*, 2010; 24(4): 404-416.
50. Instituto De Pesquisa Econômica Aplicada (IPEA). Brasil: o estado de uma nação – mercado de trabalho, emprego e informalidade. Tafner, Paulo, editor. Rio de Janeiro: IPEA, 2006.
51. Instituto Nacional Para La Educación De Adultos (INEA). Andragogia (Lectural, Año 9). México, D. F. Disponível em: <http://tecnoeduka.110mb.com/documentos/teoria%20prendizaje/Andragogia%202.pdf>>. Acesso: Fevereiro/2013, 2007.
52. Juran, J.M. A Qualidade Desde o Projeto: Novos Passos para o Planejamento da Qualidade em Produtos e Serviços., São Paulo, 1992.
53. Kiljander, H. 2004. Evolution and usability of mobile phone interaction styles. Tese (Doutorado em Tecnologia). Helsinki: Helsinki University of Technology.
54. Kotler, P. Administração de marketing: análise, planejamento, implementação e controle. São Paulo: Atlas, 1998.
55. Koskela, L. Application of the new production philosophy to construction. Stanford Center for Facility Engineering, Technical Report, 1992; 72-75.
56. Koskela, Lauri. An exploration towards a production theory and its application to construction. 298p. Doctor of philosophy - VTT Technical Research Centre of Finland, Helsinki University of Technology, Espoo, 2000.

57. Krüger, J. A.; Heineck, L. F. M. Superando as fronteiras do treinamento tradicional através da disseminação dos conceitos de qualidade de vida no trabalho – um estudo de caso no assentamento de cerâmica. In: XVII Encontro Nacional de Engenharia de Produção- ENEGEP. Gramado- RS, 1997.
58. Lacerda, D. P., Dresch, A., Proença, A., Antunes JR., J. A. V. Design science research: A research method to production engineering. *Gestão & Produção*, 2013; 20(4): 741-761.
59. LEOPARDI, M. T. Metodologia da pesquisa em saúde. 2 ed. Florianópolis, UFSC, Pós-Graduação em Enfermagem, 2002.
60. Lingard, Helen; HOLMES, Noni. Understandings of occupational health and safety risk control in small business construction firms: barriers to implementing technological controls. *Construction Management & Economics*, 2001; 19(2): 217-226.
61. Liker, J. K. O Modelo Toyota: 14 princípios de gestão do maior fabricante do mundo. Porto Alegre: Bookman, 2005.
62. Lillrank, P. The transfer of management innovations from Japan. *Organization Studies*, 1995; 16(6): 971-989.
63. Lowe, R. Beyond “eye candy”: improving learning with animation. USA: Curtin University of Technology, 2001.
64. Lowe, R. e Schnotz, W. A unified view of learning from animated and static graphics. In: R. Lowe e W. Schnotz (Ed.). *Learning with animation: research implications for design*. New York: Cambridge University Press, 2008.
65. Manson, N. J. Is operations research really research? *Orion*, 2006; 22(2): 155-180.
66. MATTAR, J. Games em educação: como os nativos digitais aprendem. São Paulo: Person Prentice Hall, 2010.
67. Mayer, R. E. *Multimedia learning*. Second edition. Cambridge University Press: Library of Congress, 2007.
68. March, S. T.; Smith, G. F. Design and natural science research in Information Technology. *Decision Support Systems*, 1995; 15: 251-266.
69. May, M. *Toyota: a fórmula da inovação*. Rio de Janeiro: Elsevier, 2007.
70. Moore, M.; Kearsley, G. *Educação a Distância: uma visão integrada*. São Paulo: Thomson Learning, 2007.
71. Moreira, M. A. *A teoria da aprendizagem significativa e sua implementação em sala de aula*. Brasília: Universidade de Brasília, 2006.

72. Mutti, C.N. Treinamento de mão de obra na construção civil: Um estudo de caso. Florianópolis, 1995. 132f. Dissertação (Mestrado em Engenharia Civil) - Curso de Pós-Graduação em Engenharia Civil, Universidade Federal de Santa Catarina, 1995.
73. Narusawa, Toshiko; SHOOK, John. Kaizen Express: fundamentos para a sua jornada lean. Lean Institute Brasil - São Paulo, SP, 2009.
74. NEIL, Theresa. Padrões de design para aplicativos móveis. São Paulo: Novatec, 2012.
75. Nevins, M. R., Macal, C. M., Love, R. J., & Bragen, M. J. Simulation, animation and visualization of seaport operations. *Simulation*, 1998; 71(2): 96-106.
76. NORMA NBR ISO 9000: 2000 – Sistemas de Gestão da Qualidade – Fundamentos e Vocabulário, 2004.
77. Ohnuma, D.K. e Cardoso, F. F. Exclusão social e desenvolvimento humano: Análise preliminar de duas empresas construtoras da região Metropolitana de São Paulo. In: XI Encontro Nacional de Tecnologia do Ambiente Construído. Florianópolis: ANTAC, 2006.
78. Oliveira, A. M. S. S de. Construção e validação de um modelo de transferência do conhecimento com base em treinamento de operários da construção civil. Tese (Doutorado). Universidade Federal de Santa Catarina. Florianópolis, 2010.
79. Padovani S., Puppi M. B. e Schlemmer A. Modelo descritivo para interfaces de aplicativos em smartphones. *Revista Brasileira de Design da Informação/Brazilian Journal of Information Design São Paulo*, 2017; 17(1).
80. Paladini, E. P. Gestão Estratégica da Qualidade – Princípios, Métodos e Processos. São Paulo, 2009.
81. PARK, Chang-Hyun; JANG, Gilsoo; CHAI, Young-Ho. Development of a virtual reality training system for live-line workers. *International Journal of Human-Computer Interaction*, 2006; 20(3): 285-303.
82. Patmore, C. Curso completo de animación. Los principios, práctica y técnicas de una animación exitosa. Barcelona: Acanto, 2004.
83. Peffers, K. et al. A Design Science Research Methodology for Information Systems Research. *Journal of Management Information Systems*, 2008; 24(3): 45-77.
84. Perassi, R. Do ponto ao pixel: sintaxe gráfica no videodigital. 1ª ed. Florianópolis, Brasil: CCE/UFSC, 2015; 116.
85. Picchi, Flávio A. Oportunidades de aplicação da Lean Thinking na construção. In: Ambiente Construído- Revista da Antac. Porto Alegre, 2003.

86. PIDD, K. Organizational barriers to training transfer: The role of workplace social controls and normative behavior in workforce development. In: A.M. Roche, J. McDonald (Eds) *Catching Clouds: Exploring Diversity in Workforce Development for the Alcohol and Other Drug Field*, Adelaide: National Centre for Education and Training on Addiction (Nceta), p135-144, 2002. Disponível em: <<http://www.nceta.flinders.edu.au/publications>>
87. Pozzobon, C. E.; Heineck, L. F. M; Freitas, M. C. D. Atualizando o levantamento de inovações tecnológicas simples em obras. São Paulo, SP. In: X Encontro Nacional de Tecnologia do Ambiente Construído, São Paulo, 2004; 13.
88. PORTUGAL, Cristina. Design and the Contemporary Languages in Education. *Blucher Design Proceedings*, 2014; 1(2): 339-350.
89. QUERINO FILHO, Luiz Carlos. *Desenvolvendo o seu primeiro aplicativo android*. Novatec Editora LTDA, 2013.
90. ROMME, A. G. L. Making a difference: Organization as Design. *Organization Science*, 2003; 14(5): 558-573.
91. ROMANEL, F. B. *Jogo “desafiando a produção”: uma estratégia para a disseminação dos conceitos da construção enxuta entre operários da construção civil*. Curitiba, 2009. 155p. Dissertação (Mestrado em Construção Civil) - Programa de Pós- Graduação em Construção Civil. Universidade Federal do Paraná, 2009.
92. RUAS, R. Desenvolvimento de competências gerenciais e contribuição da aprendizagem organizacional. In: Fleury, M. T. L.; Oliveira JR., M. de M. *Gestão estratégica do conhecimento: integrando aprendizagem, conhecimento e competências*. São Paulo: Atlas, 2001; 242-269.
93. Samartino, M.; Torres, M. de Carvalho (Org.). *Educação de Adultos. Cadernos de Formação nº 3*. (Disponível em http://www.socialgest.pt/_dlds/EFA_Educaoadultos1997.pdf. Acessado em 15/08/2016).
94. Santana, L.; Brandstetter, M. C. G, de O.; Amaral, T. G. do. *Construção Enxuta: Guia Prático para os Trabalhadores da Construção Civil*. Funape – UFG. Goiânia, 2010.
95. Santaella, Lucia. *Matrizes da linguagem e pensamento sonora visual verbal: aplicações na hipermídia*. 3. ed. São Paulo: Iluminuras FAPESP, 2005.
96. SESI - Serviço Social da Indústria. *Perfil do trabalhador formal brasileiro / SESI.DN. – 2. ed., rev. ampl. – Brasília: SESI/DN, 2005.*
97. SIECKENIUS DE SOUZA, C. *The semiotic engineering of human computer interaction*. Cambridge, MA: The MIT Press, 2005.

98. SILVA, E. L. da; MENEZES, E. M. Metodologia da pesquisa e elaboração de dissertação. Florianópolis: Editora UFSC, 2005.
99. SIMON, H. A. The Sciences of the Artificial. 3rd ed. Cambridge: MIT Press, 1996.
100. SHINGO, S. O Sistema Toyota de Produção: Do ponto de vista da engenharia de produção. 2 ed. Porto Alegre: Artes Médicas, 1996; 291.
101. Schulz, M., Robnagel, C. S. Informal workplace learning: An exploration of age differences in learning competence. In: Learning and Institutional Development, Jacobs University, Campus Ring 1, 28759 Bremen, Germany, 2009.
102. SPEAR, S.; BOWEN, H. Decoding the DNA of the Toyota Production System. Harvard Business Review, 1999.
103. TAYLOR, M. Transfer of learning in workplace literacy programs. Adult Basic Education: An Interdisciplinary Journal for Adult Literacy Educators. 2000; 10(1): 3-20.
104. TAKEDA, H. et al. Modeling Design Process. AI Magazine, 1990; 11(4): 37-48.
105. TEIZER, Jochen; CHENG, Tao; FANG, Yihai. Location tracking and data visualization technology to advance construction ironworkers' education and training in safety and productivity. Automation in Construction, 2013; 35: 53-68.
106. Thiollent, Michel. Metodologia da pesquisa - ação. 2. ed. São Paulo: Cortez, 1986.
107. Thomaz, E; Helene, P. Qualidade no Projeto e na Execução de Alvenaria Estrutural e de Alvenarias de Vedação Em Edifícios. São Paulo, 2000.
108. Tremblay, M. C.; Hervner, A. R.; Berndt, D. J, Focus Groups for Artifact Refinement and Evaluation in Design Research. Communications of the Association for Information Systems, 2010; 26(27): 599-618.
109. Van AKEN, J. E. Management Research Based on the Paradigm of the Design Sciences: The Quest for Field Tested and Grounded Technological Rules. Journal of Management Studies, 2004; 41(2): 219-246.
110. Vaishnavi, V.; Kuechler, W. Design Research in Information Systems. 2009. Disponível em: <[http:// desrist.org/design-research-in-information-systems](http://desrist.org/design-research-in-information-systems)>. Acesso outubro de, 2017.
111. Vygotsky, L., Pensamento e linguagem. São Paulo, SP: Martins Fontes, 4ª Edição, 2008; 224.
112. Zerbini, T. Avaliação da transferência de treinamento em curso a distância. Tese de doutorado. Instituto de Psicologia. Universidade de Brasília. Brasília, 2007; 321.