STEAM and Digital Storytelling: a case study with high school students in the context of Education 4.0

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Abstract. Today's professionals need to be trained for more than repetitive activities. Therefore, it is the school's role to promote activities that enable students to think creatively and innovatively. So, they can develop the skills and competences that are required in the 21st Century. This redefines Education, known as Education 4.0. In this paper, we present a case study that was carried out to introduce didactic 4.0, to promote greater engagement in High School. Students followed the STEAM methodology (an acronym for Science, Technology, Engineering, Arts and Mathematics), being able to work skills more interactively and autonomously, through the production of Digital Storytelling (DS). After the study, a qualitative analysis of the results was performed. This analysis indicated that the activities with STEAM and DS helped the students to be more participative and interested in their learning. These methodologies allowed to disseminate the contents of created narratives and to stimulate some skills and competences of the 21st Century. Therefore, it is hoped to create partnerships with teachers from other subjects to carry out new activities in 4.0 format. In this way, be able to involve other technologies, such as robotics, augmented reality, gamification, in order to provoke positive changes in the educational scenario.

Keywords: Education 4.0, Digital Storytelling, STEAM, Skills and Competences, 21st Century.

1. Introduction

Information and Communication Technologies (ICTs) have proven to be allies in sectors such as industry. For education, this reality has not been different. Today, in Basic Education, for example, technological resources are already used for the facilitation and dynamism of didactic content, which has resulted in good student performance.

However, there is still a need for more aligned schooling in the contemporary world that prepares students to deal with the challenges of the 21st Century. This need arises, especially in the face of the current process of digitization of companies, known as Industry 4.0. Industry 4.0 is discussed about the professional qualification of young people to meet the recent social changes, that is a new parameter that redefines the education format, known as Education 4.0 [Puncreobutr, 2016].

To meet the shortage of qualified human resources to act in this new market concept, Education 4.0 suggests practices in the classroom using various technologies (programming language, robotics, gamification, among others). These technologies

support and enable the development of skills and competences in students, such as problem-solving, communication, collaboration, creativity, innovation, autonomy, technological domain. Consequently, these skills and competences form professionals fit to work in Industry 4.0 [Coskun et al., 2016].

In this sense, to be made available human capital to meet this demand, it is indicated to carry out training from Basic Education (Early Childhood, Primary and, Secondary Education). This training allows young people to be more technologically grounded to entering Higher Education and who have a greater chance of employability in Industry 4.0 [Pérez-Pérez et al., 2018].

According to the Basic Education Assessment System (SAEB) in Brazil, the High School needs special attention. Evidence shows that this level of education has been stagnant since 2009 and has added little to the cognitive development of Brazilian students. The SAEB in 2017 showed that only 1.62% of the students in the last grade of High School achieved learning levels considered adequate by the MEC in Portuguese Language [Inep, 2018]. In general, the low quality of teaching at this stage impairs school education and, consequently, delays the social and economic development of the country.

In this way, this paper presents the accomplishment of a case study to promote a greater engagement to the students of the third grade of High School in Brazil. For that, Digital Storytelling - DS (storytelling art) was produced using the STEAM methodology (an acronym for Science, Technology, Engineering, Arts and Mathematics). The findings of this case study show that students can learn content in a more interactive and didactic way, with the possibility of training skills related to Education 4.0.

The paper is organized in VI sections. Section II defines the main terms and concepts of Education 4.0, relating STEAM and Digital Storytelling. Section III describes the planning and execution of the case study. Section IV describes the qualitative analysis. In section V, contains the discussion of the results. Finally, the conclusions and future works are presented in section VI.

2. Background

The first mention for Education 4.0 was given by [Scheer, 2015]. He presents a learning model that meets the needs of Industry 4.0. From this, it was possible to present the necessary facets to configure a classroom with didactic 4.0, as seen in Table 1.

Table 1. Facets of Education (Scheer, 2015)

Characteristics /facets	Description
Personalization	Didactic material is prepared for different learning types (interactive book and interactive video)
Gamification	Playful elements to help at motivation.
Learning Manager System	Practical activities and access to learning modules
Adaptability	Course modules adapted according to knowledge and learning.
Support Programs	Analytics-Methods to find learners with difficulties
Smart Question and Answer System	Intelligent teletutors to support the students
E-Assessment	Correction work automatically via the system

In this context, traditional teaching methods are in its limit concerning the training of skilled labor to act in this new market concept. Likewise, initiatives in Education 4.0 can ensure that future professionals are equipped with the necessary competences. Thus, education and technology are the main sources for addressing the challenges of Industry 4.0 [Mourtzis, 2018].

Students 4.0 increasingly need to develop cognitive skills to deal with a changing technological environment, such as mathematical and logical reasoning, data processing, project management. In addition, they also need to have non-cognitive skills, such as teamwork, critical thinking, interpersonal relationships, creativity, problem-solving, among other skills of the 21st Century [Pérez-Pérez, 2018].

The term Education 4.0 is still recent. Consequently, there is a minimum of written literature, including empirical study realized with technologies focusing on 21st century skills and abilities. Much of the research on Education 4.0 comes from blog or online journal article that is written by experts [Ayub et al., 2018].

In this way, it is relevant to choose the appropriate methodology to work these skills and competences within a classroom. For this case study, STEAM and DS were chosen, which can be framed within the personalization facet mentioned above. Also, these methodologies allow the production of differentiated materials, which awakens students' attention and curiosity, making them more engaged in their learning.

2.1 STEAM and Digital Storytelling

STEAM is an acronym in English for Science, Technology, Engineering, Arts and Mathematics. This methodology guides educational projects focused on the development of skills of the 21st Century more interactively and autonomously. Through this methodology, students become more active in their learning, following the steps: investigate, discover, connect, create and, reflect [Education Closet, 2018].

In this context, it is possible to carry out a multidisciplinary work, being able to integrate Arts, for example, to the other areas of the nomenclature STEAM. This happens because Arts Education also improves academic performance and makes students more involved in their learning. In this way, STEAM allows dealing with themes such as Humanity, Language, Culture, Architecture, Literature, Music, Dance, Cinema, Theater, Design, Sculpture, Painting, Animation, and Photography.

Another methodology present in Education 4.0 is Digital Storytelling (DS). Digital stories can be created in all areas of education. For example, DS can be produced in class such as Portuguese, Geography, Mathematics, English, Physics, Sciences, Chemistry, among others and at all levels of education, such as Early Childhood, Elementary, High School and Higher Education.

DS, when applied to education, becomes useful because it stimulates the student's creativity during the development of their stories. Thus, this methodology can be used as a complement to traditional teaching methods, personalizing learning and improving the involvement of students in their teaching and learning processes [Robin, 2008].

Therefore, for this study, we perceived the possibility of working STEAM in conjunction with DS. In order to reach a DS a series of multimedia resource combinations are made, including songs, texts, video clips and photographs produced by students, that are gathered and organized with the use of the computer [Robin, 2008]. In this way, a

case study was conducted to analyze how these two methodologies together behave within a classroom. The case study will be presented in the next section.

3. Case Study

The case study was carried out in a school of the Basic Education in Brazil. For this case study, the classes of the 3rd grade of High School were chosen. The students were organized into 27 teams, each containing between 3 to 5 students. The teams should represent the following narratives defined by the teacher of the Writing class: tales, chronicles, urban and regional legends. It should be noted that participants were distributed according to their experience with technology and/or domain of narrative content. For this, a characterization questionnaire was used before the execution of the case study in order to identify the profiles of the students and to assist in the formation of the teams with balanced experiences.

This case study had the initial goal of promoting engagement to students, using the technological resources available in the school. Consequently, it was possible to make them more participatory and interested in transmitting the desired knowledge in the class.

3.1 Case Study Planning

To identify the benefits of using DS and STEAM applied to Education 4.0, the case study was divided into two parts: (1) implementation of the proposal and (2) evaluation of the proposal. In the first part, it was talked with the Coordination of Informatics in Education of the school about the need to carry out work with the High School students. The coordination oriented the researcher responsible by the case study to the Writing class, mainly due to the requirements and challenges of the National High School Examination in Brazil, which students were being prepared. In this sense, both STEAM and DS were used to promote greater engagement in the classroom and to provide adequate school education, based on the context of Education 4.0.

In this case study, the combination of STEAM with DS had the following steps and activities: to investigate (to think about the idea of digital history and to search the content of the narrative), to discover (to write script and to plan recordings of digital stories), to connect (to gather the media for editing), to create (to edit, save and share DS) and to reflect (to watch the DS done by other teams and discuss the challenges and difficulties). DS activities were created by the writing teacher and researcher, based on the STEAM steps.

For the edition of the DS was adopted the video editor Movie Maker because it is the tool present in the computers of the school. In addition, the teachers had previously been trained by the Coordination of Informatics in Education to use this tool as a further resource in their pedagogical proposals. For this reason, students had already gained some experience in developed activities in the computer lab with this video editor.

In the second part of the case study, the process of evaluating students' perceptions about work done in the classroom was defined. The data collection for the case study was through interviews with some students selected by the teacher of the class. Students were selected based on teacher recommendation. Only ten students were selected for the interview because the students were in the assessment period. Therefore, they had commitments to other school activities. In addition, the researcher responsible for carrying out the case study had a short time to complete this part of the study. For the

qualitative analysis of the data obtained in the 2nd part of this case study was used the tool Atlas.ti version 6, following the procedures of the Grounded Theory method [Strauss e Corbin, 2008], detailed in section IV.

3.2 Case Study Execution

After the meeting between the researcher and the school's coordinator, the researcher talked with the Writing teacher about the proposal for this case study. From this moment, it was possible to define the target audience and content that would best suit the proposal, through the concept, objective and, methodology presented.

In this sense, the classes of the 3rd grade of High School was selected to remember the content of narratives and open the way to other types of textual genres. The steps are described below:

1. Investigate: with the proposal to create storytelling, teacher decided to work with narratives, such as: tales, chronicles, urban and, regional legends. Students could make adaptations in the original works or create authorial stories. Subsequently, the library and the internet of the school were used to research the contents.

2. Discover: to register the research and identify the key elements, such as characters, sceneries and, scenes, the students delivered scripts to the Writing teacher. These scripts were corrected, returned to the students and, served as a basis for planning. The teams were oriented to scheduling the date and time for rehearsals, equipment selection, scenarios and, costumes, as well as verifying that the actors were rehearsed since at the time of filming everything should work because they received a deadline for delivery of the media.

3. Connect: the collected material was delivered in the computer lab and organized into folders on the school server. In the server were created folders for each team which served as the environment for the production and monitoring of the productions. The recordings were evaluated so that the students could improve when needed.

4. Create: students had the autonomy to produce their story (order of scenes, soundtrack, visual effects, transitions, opening screens and, credits). For this, the students followed the structure of a writing: introduction, development and, conclusion. When ready, the stories were watched in the lab so that students could share their ideas with each other.

5. Reflect: in the end, students were able to reflect on their participation in the project: difficulties encountered, impressions obtained and, experiences. Posteriorly, 10 students were released by the teacher so they could give testimonials about these impressions of the storytelling creation project. This selection was made random.

The activities were accompanied by the teacher and the monitor in all the stages, from the beginning to the delivery of the projects. In this way, the project was evaluated as a grade of discipline. Subsequently, a qualitative analysis was performed about the participants' experiences obtained in the interviews.

Table 2 presents the order of project activities of production and editing of digital narratives as proposed the Writing class.

Table 2. Overview of activities carried out.

Order	Activities
1	Presentation of the proposal and definition of the project schedule with the school teacher and the coordinator.
2	The teacher informs the coordination of informatics about the beginning of the project.
3	Laboratory monitor performs a workshop on DS and presents the steps of the STEAM methodology for the construction of the projects.
4	Reading, production, and correction of the scripts.
5	Production of the recordings with the accompaniment of the teacher and the monitor of the laboratory.
6	Evaluation of the first version of the delivered media and orientation for re-recordings of some scenes.
7	Guidance and follow-up in story editions during the class.
8	Guidance and follow-up with the teams that had difficulties in DS production after class - optional.
9	Delivery of the projects
10	The capture of student feedback (through interviews).
11	Presentation of DS built by teams in the computer lab

3.3 Example of a project created

Figure 1 shows one of the DS produced by the students called "The Legend of the Boto", that is an Amazon legend in Brazil. The story tells about the boto that turns into a handsome man, wearing white clothes and a hat. During the days of the party, he seduces girls by taking them to the bottom of the river. In this case study, students recorded scenes telling this story.

Figure 1. Storytelling "The Legend of Boto".

4. Qualitative Analysis

The qualitative analysis was based on Grounded Theory (GT) procedures [Strauss e Corbin, 2008]. The qualitative data were analyzed using a subset of the steps of the coding process suggested by Strauss and Corbin [2008] for the GT method: open coding (1st step) and axial coding (2nd step).

In the first step of the GT (open coding), the codes were created (concepts to understand the perception of DS production) according to the participants' feedback. Subsequently, the codes were grouped according to their properties, forming concepts that represent categories. Finally, these codes were related to each other - axial coding (2nd step). The researcher did not choose a central category because the GT rule is the circularity between the collection and analysis stages until the theoretical saturation is reached [Strauss e Corbin, 2008]. Therefore, the selective coding was not performed (3rd step of the GT method).

The purpose of the qualitative analysis in this case study was to understand how DS in conjunction with STEAM can contribute to the development of 21st Century skills and competences. Thus, the steps of open and axial coding were sufficient to understand whether DS in conjunction with STEAM supports teaching and learning and fosters the development of skills and competences of the 21st century.

A. *Point of view about the contribution of DS and STEAM in the teaching and learning process*

Some participants said that DS and STEAM helped to fix the narrative content (see the quotation from P10 below). One participant stated that DS and STEAM helped to improve the grade (see the quotation from P8 below). In addition, one participant noted that it was possible to work with vestibular concepts (see the quotation P1 below).

> *"I think storytelling was important to our learning because helped us to memorize content" (P10).*
>
> *"This stimulated my creativity and helped me improve, including my grades, because I was able to look at the other part of the writing" (P8).*
>
> *"Several of these skills and concepts, which we use during the project, is also considered in vestibular, tests and, exams. That is, it was a project that contributed to our academic formation" (P1).*

B. *Opinion about the contribution of DS and STEAM in the development of skills and competences*

Through the student's feedback, it was possible to identify that DS and STEAM can contribute to education more aligned to the 21st Century. In addition, it permits to prepare students for challenges outside the classroom. Some opinions were: DS in conjunction with STEAM (I) stimulates creativity (see the quotation from P7 below); (II) stimulates authorship (see P3 quotation); and (III) stimulates the concentration (see the quotation from P1 below).

> *"It was challenging to have to do a script and think about how that story would be retold using technology. This stimulated my creativity" (P7).*
>
> *"We recorded our film, edited it the best way, to pass an idea, to pass information and also to transmit knowledge" (P3).*
>
> *"From its production until its exhibition, was a project that added in our knowledge and demanded many skills, such as concentration, [...]" (P1).*

C. Point of view about the contribution of DS and STEAM in the configuration of the classroom in a more motivating space for the student to learn

Some participants reported that DS with STEAM was fun and engaged work (see the quotation from P3 below). In addition, one of the students believes that it is an activity that arouses the attention (see the quotation from P5 below). Another participant said that it promoted engagement and teamwork (see the quotation from P8 below).

"What at the beginning was to be a project, became something very fun and engaging; and developed passion in other people and in me" (P3).

"[...] is something different that arouse the attention of any student because we use what is traditional and contemporary: art and technology. The theater, the media, the edition. The student becomes interested in this [...]" (P5).

"The DS was great fun, one helping the other through teamwork. It was really cool!" (P8).

D. Point of view about the contribution of the STEAM methodology used in the production of DS

In that sense, one participant said that the STEAM methodology helped to bring more meaning to DS (see the quotation from P7 below). In addition, a student believes that STEAM steps helped to organize the thinking for the work in question (see the quotation from P6 below). In addition, one participant realized that STEAM steps helped to guide the DS production (see the quotation from P4 below).

"The production of DS requires steps that must be taken calculatedly so that do not lose the sense. This helped us a lot in the proposal of the work" (P7).

"We saw how to do step-by-step storytelling, we saw how to edit, [...] We learned to balance a lot of things: patience, thoughts, routine, [...]" (P6).

"What caught my attention and what I learned was the importance of the steps. My team had a lot of difficulty in turning text into a film, and what helped us was the script" (P4).

E. Opinion about the use of technological resources in the production of DS

About the use of technological resources in the production of DS, some opinions were: DS (I) enabled access to technological resources (see the quotation from P8 below); (II) provided the creation of digital texts (see the quotation from P6 below); (III) allowed to have a greater technological domain (see the quotation from P2 below);

"I especially do not have many opportunities with the computer, but here I had this contact [...] Using technology, we had another vision of our productions" (P8).

"I see this as a didactic way for us to learn, instead of just being in the classroom writing what the teacher is asking for" (P6).

" In the edition of DS, I learned a lot. Something that we did not dominate, now we have more domain" (P2)

Finally, it is possible to say that DS in conjunction with STEAM contributes to the construction of knowledge. Furthermore, DS and STEAM applied in a specific class stimulate skills such as authorship, creativity, technological domain, teamwork, collaboration, communication, among others. In addition, it allows students to create, innovate and, solve problems in the classroom.

5. Discussions

In general, DS has proven to be an interesting methodology for students to learn and to develop 21st Century competences and skills, involving Technology and Art from the STEAM methodology. In this sense, the goal of the case study presented in this paper was to generate a greater empathy in the students in the Writing class, making them more participatory and interested in their learning, and consequently, promoting an education focused on the 21st Century.

This practice is based on Wallon's Theory of Affectivity [Wallon, 1941], which argues that we learn more easily in what we develop affection. So, the dynamics of class, interaction with classmates, and technological resources can help in the preparation of a differentiated class that motivates and makes the student think creatively and innovatively.

In addition, the project steps need to be accompanied by the teacher, the one who challenges, guides and, makes the student feel secure in their production. The teacher's orientation provoked interest in informatics lab and its tools. So, even with difficulties, because it is a new and differentiated activity, students learned and produced their stories with the support and encouragement of the teacher.

The findings identified in the qualitative analysis show that students can learn content, with the possibility of training skills related to Education 4.0. Therefore, it can be considered an initiative capable of support the teaching and learning processes, in addition to allowing a more aligned work to the contemporary world.

In this case study, some benefits are presented in producing DS with STEAM. It is perceived that this methodology can facilitate the learning of the content, improve the grade of students, and train students for the exams. DS with STEAM still helps the formation of skills and competences, such as creativity, logical thinking, autonomy, teamwork, problem-solving, among others. Finally, all the students were able to transform their projects written in digital stories, an activity that relied mainly on the innovation and creativity of students, elements related to Education 4.0.

6. Conclusions and Future Work

This paper presented a case study that had the goal of promoting a greater engagement to the students of the third grade of High School, making them more participatory and motivated in their learning. The students provided feedback about DS and STEAM activities performed in the school.

With the qualitative analysis of this case study, it was possible to perceive that the students developed well the skills of creativity, autonomy, and textual interpretation. Students also provided positive feedback on other skills, such as the use of technological tools to help stimulate imagination and concentration.

It's worth pointing out that most schools follow the traditional curriculum and teaching methods stipulated in their academic calendars. In this sense, this can be seen as a barrier for the teacher to introduce technological resources into their pedagogical proposals. Moreover, the education professional often feels compelled to follow the book with the contents and exercises contained. However, through this case study, it can be observed that it is possible to unite educational content with technology.

With this initiative, it is hoped to open new paths to other projects in Education 4.0 format in partnership with teachers from other classes and schools, involving different

technologies (robotics, augmented reality, gamification, among others). In this way, it is believed that it will be possible to improve teaching and learning, in addition to provoking positive changes in the Brazilian educational scenario.

Acknowledgment

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