

## Digital video as a way of evaluating learning in Mathematics

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**Abstract:** The aim of this article is to reflect on the potential of producing and using digital videos with mathematics content in the process of assessing school learning. To do so, we bring the analysis of three videos entered in a festival and the speeches of their producers in a questionnaire and a group interview. It deals with an excerpt from an Art-Based Educational Investigation, which adopted A/r/tography as a qualitative research methodology and, as a theoretical reference, the notions of Human-Beings-With-Media were used as a knowledge producing unit, Art as an aesthetic experience and the estrangement effect of the Didactic Theater Theory. As a result, similarities were observed, in the didactic functions, between theater, cinema and the analyzed videos, such as the interdisciplinarity of contents, the multimodality of languages and humor, culminating in the idea of using videos as a form of evaluation.

**Keywords:** Digital Videos. Art as Experience. Learning Assessment. Human-Beings-with-Media.

### El vídeo digital como forma de evaluar el aprendizaje en Matemáticas


**Resumen:** El objetivo de este artículo es reflexionar sobre el potencial de producir y utilizar videos digitales con contenido matemático en el proceso de evaluación del aprendizaje escolar. Para ello, traemos el análisis de tres videos ingresados en un festival y los discursos de sus productores en un cuestionario y en una entrevista grupal. Se trata de un extracto de una Investigación Educativa Basada en el Arte, que adoptó la A/r/tografía como metodología de investigación cualitativa y, como referente teórico, se utilizaron las nociones de Ser-Humano-Con-Medios como unidad productora de conocimiento, El Arte como experiencia estética y el efecto de extrañamiento de la Teoría Didáctica del Teatro. Como resultado, se observaron similitudes, en las funciones didácticas, entre el teatro, el cine y los videos analizados, tales como la interdisciplinaria de los contenidos, la multimodalidad de los lenguajes y el humor, culminando en la idea de utilizar los videos como una forma de evaluación.


**Palabras clave:** Vídeos Digitales. El Arte como Experiencia. Evaluación del Aprendizaje. Seres-Humanos-con-Medios.

### O vídeo digital como forma de avaliação de aprendizagem em Matemática

**Resumo:** O objetivo desse artigo é refletir sobre a potencialidade da produção e do uso de vídeos digitais com conteúdos de Matemática no processo de avaliação de aprendizagem escolar. Para tanto, trazemos a análise de três vídeos inscritos em um festival e das falas dos seus produtores em um questionário e em uma entrevista em grupo. Trata-se de um recorte de uma Investigação Educacional Baseada em Arte, que adotou a A/r/tografia como metodologia de pesquisa qualitativa; como referencial teórico, foram utilizadas as noções de Seres-Humanos-Com-Mídias como unidade productora de conhecimento, a Arte como experiência estética e o efeito de estranhamento da Teoria do Teatro Didático. Como resultado, foram observadas semelhanças nas funções didáticas entre o teatro, o cinema e os vídeos analisados, como a interdisciplinaridade de conteúdos, a multimodalidade das linguagens e o humor,




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culminando na ideia da utilização de vídeos como forma de avaliação.

**Palavras-chave:** Vídeos Digitais. Arte como Experiência. Avaliação de Aprendizagem. Seres-Humanos-com-Mídias.

## 1 Introduction<sup>1</sup>

According to Borba and Villarreal (2005) knowledge is produced by a collective of humans and non-humans who, as interact, modify themselves. In this study, in particular, we seek to comprehend how the collective Human-Beings-With-Media, utilized art in their videos productions which express mathematical ideas in a festival. For Lincoln and Guba (1985) there are research methodologies aligned to different knowledge conceptions. There is a strict relationship between epistemology and pedagogy. “A vision of knowledge that emphasizes the media role, which stands for the unit Human-Beings-With-Media, must be in resonance with these other components if we want to carry on research and coherent practices” (Borba & Villarreal, 2005, p. 47, own translation)<sup>2</sup>.

For the production of the analyzed videos in this research, there was a relationship between humans and humans with technologies since the referred activity, in all its steps (research, script, shooting, edition and disclosure) the digital technologies were present, been in mobile devices used for the video footage like phone cams, in internet to do researches with the contents addressed in videos, in edition software or even in social medias used to communicate and share their ideas;

In this relationship, the technologies are just costar artifacts, they act together with humans, as protagonists in the knowledge process. Something alike is presented by Augusto Boal (2019), as using the word spectator (spect + actor), to refer to a public that is not just spectators but actors. In the Brechtian theater, between audience and stage there is no curtain, that means that there is a break of the “fourth role”, a technique that gets the actor closer to the audience and the audience closer to the actor, so collectively, products knowledge. This feature has been given to Brecht’s theatral theories, the title of theatral plays (or learning, as prefers to translate Ingrid Koudela, 1991).

In this study we will present some dialogues between Arts, Mathematics and technologies in three different theoretical contexts: vision of knowledge, presented by Borba and Villarreal (2015) in *Humans-With-Media*; the conception of Art proposed by Dewey (2010) in his book *Art as Experience* and the conception of Distancing Effect, discussed by Brecht in his didactic theatre theory, presenting the studies of Montagnari (2010).

Since it is an Educational Research Based on Art (3), we understand that the A/r/tography would be an adequate methodology for our investigation proposal. A/r/tography is the English acronym for (*A=Artist; R=Researcher; T=Teacher*) that, translated to Portuguese means *Artista/Pesquisador/Professor*. This kind of research is, according to Scucuglia (2019), a qualitative approach which explores three contexts of teaching and learning esthetic experiences: scenario/phenomenon of investigation, analytical interpretative lens, and the form of results socialization.

The scenario of this research was developed in a process of student’s videos with mathematical content broadcast by a video festival (4). The video (while product, production process and usage), in this study, is understood as art (mediatic art) in the vision of John Dewey

<sup>1</sup> This article is an excerpt of a doctoral thesis presented in the Math Education Post-Graduation Program of the Universidade Estadual Paulista “Júlio de Mesquita Filho”, Rio Claro *campus*.

<sup>2</sup> A view of knowledge that emphasizes the role of media, symbolized by the humans-with-media unit, must be in resonance with these other components if we are to develop coherent research and practice.

and the analytical interpretative lens used in the investigation bring up the ideas of the Becht's didactic theatre theory adapted to the videos.

From the seven videos analyzed in this doctorate, three were selected: one from Elementary School (É D+), one from High School (Função Seno) and one from College (Como os peixeiros sobreviviam no século XIX). The selection of these videos, for this article, was made by the fact of having our eyes directed to the potentiality of the referred videos production as an instrument of school learning assessment in the perspective of Luckesi (1999). To assess, by this meaning, is a careful (and lovely) look from the teacher to the experiences of his students during the learning process. About experiences,

could be even said that everything exists in function of the mutual relationships, through which the bodies act one over the other, reciprocally modifying themselves. This acting over another body and the suffering from another body, is what we call experience. Our experience conception is far since from being purely human attribute, since it widens to the permanent activity of all bodies, one to another (Westbrook & Teixeira, 2010, p. 33).

As we studied (and assessed) these experiences, we sought identify the evidence of the strangeness, effect that, in Brecht's vision, has the function of reflect about the social naturalized as passive of changing in the process of society transformation. What is so familiar in scholar education that naturalizes, becoming invisible to us? Maybe that is what art can show us, what hardly would be noticed in other way, the called traditional teaching methodologies. The researcher who makes A/r/tography according to Cândia (2019, p. 7),

thinks presenting the results of his research appropriating of another forms of thinking and saying stemming from art and its diverse languages, so in this way hope to obtain unveiling feelings and sharpen viewpoints to points that, if presented by another way, would go unnoticed.

Which points of this research would go unnoticed if it weren't an Art Based Educational Research? I confess that, so far, we still don't have answers. Even because, in an Art Based Educational Research, we do not seek answers for questions, but to discuss questions with the objective of creating new ways of viewpoint and comprehend an object. Questions are interrogative utterances which ask the interlocutor for information, an answer, while a question is an utterance, not necessary interrogative, made as starting point to a certain theme discussion like "understanding the relationship between artistic creation and mathematics teaching". To debate this question, it was necessary to know

from the own actors/authors and actresses/authors of the videos: How was the process of media production (theme choice, Mathematics contents, kind of video and technique used, writing of the script, footage, and edition...)? What were the motivations to product the video (a school paper, an assessment, a play, or the proper festival...)? Which factors limited or complicated their papers? Who (people or institutions) contributed to the achievement of this paper? How was the experience about producing this video? And particularly the festival? What could be done by the event organization to improve the IV festival? What technologies and arts acted as actresses in this production? What mathematical ideas they intended to communicate? (Gimenez, 2023, p. 114).

To discuss these questions, three texts were used, obtained from questionnaires, interviews, and the videos themselves. Therefore, the data which were produced from a

questionnaire that, usually, the event organization has sent to the festival participants, seeking information about the video production processes and group interviews (round conversations), performed in the presential stage in Vitória/ES, with open questions so that the interviewed people could “tell” freely their mathematical esthetical experience. The analysis of these data had as an objective to identify artistic elements in their pedagogic functions and/or in the meaning and production of mathematical ideas communication, seeking evidence of strangeness by the optic of the didactic theatre theory and the *Humans-With-Media* building. (Gimenez, 2013).

The themes which emerged from the videos analyses, meaning the strangeness effect to the naturalized in the Mathematics teaching that wouldn't be produced similarly without the protagonism of the digital technologies and art were: The interdisciplinarity to contextualize mathematics questions; the use of mood as an interpreting mode, criticize and present social speech; the use of videos as a way of scholar assessment and the viewpoint to the mistake as a possibility of teaching and learning.

## 2 What do the videos show us?

The sharp evolution in the use of the Digital Technologies during the Covid-19 pandemic (in the years 2020 and 2021) has caught the attention of several researchers in the Education area, as so happened with the math educator Marcelo de Carvalho Borba who, in the attempt to explain what was happening during that historical moment, in the context of the Digital Technologies, discussed, among other questions, the use of digital videos with Math content, which was intensified during that period. However, he reminds us that this practice was already encouraged before the pandemic by the Digital Videos and Math Education Festivals project, which was launched in 2017. For Borba (2021, p. 389),

inviting students to produce mathematical videos was a research project developed before the pandemic. Having students expressing mathematical knowledge with videos, or doing research with videos, was not a solid trend in the literature. However, video production may be an alternative for education during and after the pandemic. Instead of focusing on test results, we can have students producing videos online to express what they have learned under conditions such as the pandemic. Videos can be produced collectively, with help from parents, friends, and different media. Differences in resources, including the degree of parental aid received, can be considered by teachers and school systems in a “non-ranking” type of assessment.

Borba, Souto e Canedo Junior (2022) also talk about videos from two perspectives: the pedagogical focus and the Math Education research. From a pedagogical focus point of view, “the voice of the students gains distinction, once they have become authors of the digital videos that they produce — besides participating, many times, as actors — and with which they communicate mathematical topics that have been chosen by themselves, according to their interests” (Borba, Souto & Canedo Junior, 2022, p. 34).

In this pedagogical practice, which involves Mathematics, Technologies, and Art, the assessment no longer has the classificatory character, based on grades and tests typical of the educational system, which adopts traditional teaching methodologies. Santos (2016), states that these methodologies aim at filling the students with new information and new knowledge, considering only the content assimilation and transmission, being a teacher-centered educational process, based on the teacher who is the possessor of knowledge. The student, mere receptor, is expected to reproduce, on tests, the information delivered by the teacher.

What we present in this article is the evidence of the potentiality of videos as an

instrument of assessment. However, a few topics will also be approached for the purpose of contextualizing the event as an artistic-pedagogical experiment, an expression used by Lucas Valentim Rocha and Rita Ferreira de Aquino, meaning the “space to reflect on correlations between creating and learning and the development of methodological procedures for classes” (Rocha & Aquino, 2020, p. 9) (own translation).

### 3 “É D+” Video (É demais)<sup>3</sup> — Elementary School<sup>4</sup>

The “É D+” video

*has a similar format to that of the TV program<sup>5</sup>, in which the people interviewed present, in different ways, the measuring systems. First, they mention the non-standard units, which were more used in the past. After that, they introduce contextualized situations of the use of measurement units, such as, in a cake recipe or a paper box assembly. (Video description by the authors).*

*To make the video, we used the ‘É de Casa’ program as inspiration. [...] The teacher, in the classroom, presented us with the video-making project with the math contents that we had already studied. Then, we presented all the videos in the school, and she left it up to us to take part in the festival if we wanted. [...] We made the video as schoolwork. All of us did. Those who wanted to participate in the Festival signed up for it. (Comments from the students in the round of conversation).*

These comments made by the actresses/authors go hand in hand with one of the answers given by teacher Carla on the questionnaire, in which she says

*My videos are produced aiming at the Festivals, but they are included in a pedagogical practice, in an assessment context [...] I carry out a diagnostic evaluation with my students in the first trimester of the school year and the production of videos is inserted in this context. [...] these productions follow the festival public notice criteria. (Carla’s answer to the questionnaire).*

This assessment context, mentioned by the teacher, reminds us of a comment made by teacher Ricardo Scucuglia, in one of his speeches<sup>6</sup>:

Let’s think of a situation in which the math teacher pedagogical practice comes down to the board, demonstrations, exercise solving, and the evaluation is restricted to the monthly, bimonthly test [...] There lies a huge evaluative injustice, from the multimodal point of view. Because the teacher, while explaining, will be using writing, speaking, gestures, ... and when he/she is about to evaluate, he/she says: I don’t want to listen. The student has to express his/her ideas using written verbal language alone, and that is it. (Scucuglia & Gualberto, 2020).

In this sense, the assessment proposal made by teacher Carla is fairer because it allows the students to communicate their mathematical ideas using not only written verbal language, but also the oral language, visual resources, gestures, and other non-verbal languages that are not always used (many times even forbidden) in the Mathematics class.

<sup>3</sup> The expression “D+”, when pronounced, can be understood in two different ways: 1. “de mais”, which is the combination of the preposition “de” (of or from) and the noun “mais” (more or plus); 2. “demais”, which literally means “too much” or in spoken colloquial language means “terrific” or “awesome”. So, the idea of the name of the project is “It’s terrific” or “It’s awesome”.

<sup>4</sup> Available on: <https://youtu.be/KdvQTQWQn4Q>. Accessed on: Feb 26, 2023.

<sup>5</sup> É de Casa is a program produced and aired by TV Globo since August 8th, 2015. Available on: <https://gshow.globo.com/programas/e-de-casa/>. Accessed on: Dec 29, 2021.

<sup>6</sup> “Chat with Professor. Ricardo Scucuglia and Professor Clarice Gualberto” at the IV Festival XXX, 2020. Available on: <https://www.youtube.com/watch?v=nCKo7YwevHE>. Accessed on: Dec 29, 2021.

Besides the question on assessment, this experience, with the  $\acute{E} D +$  video, has enriched the class, because it

*[...] brought a historical feature, besides the standard measurement units usually presented in the Mathematics class. How many of our Elementary School students today know, for example, what a yard<sup>7</sup> is? So, they brought this content historically contextualized and showed, in practice, where it is used in the present. (Answer by teacher Carla to the questionnaire).*

With regards to the topic of the video (Measurement Systems), we will see its applicability in two contexts: in the classroom and in everyday life out of school. In the first scene of the video, the program host interviews a Basic Education Mathematics teacher who talks about the historical context of the units of measure (emphasizing length measurements) used by different civilizations, since ancient times, such as the inch, the yard, the fathom, the foot, the cubit, as can be seen in the video (from 0min52 to 1min55).

She talks about a time in which parts of the human body were used as a reference to perform measurements, for example, the inch, unit of length measurement

created by the King of England, Edward I, in the XVI century. Its origin is connected to measuring by using the thumb, consisting of the width between the nail base and the fingertip. The average of an adult human thumb is approximately 2,54 centimeters (Silva, 2021, online).

Despite being old and although there are other reference patterns by tradition, some of these units are still in use, as is the case of the inch, which is still used to measure the diameter of pipes, screws, and even TV screens. When you buy a 32-inch TV, for example, this number refers to the measure of the diagonal of the screen, which is 81,28 cm ( $32 \times 2,54 = 81,28$ ). However, although “inch”, “feet”, etc.” are still used, the thumb is not anymore, nor is the foot, or any other part of the body perform such measurements, but their equivalent in units defined by the International System of Units.

The  $\acute{E} D +$  Program goes on with the host interviewing a cook who gives a chocolate cake recipe that can be made in just 3 minutes! She says that “a good way to learn the measurement system is by cooking. It is impossible not to be captivated by the magic of preparing food” (Video — from 2min30s to 2min36s). The host complements by saying that cooking encompasses all methods [*sic*] of knowledge, Math, Portuguese, Sciences... (Video – from 2min36s to 2min42s).

In order to make the recipe, the cook used mass and volume measurement units to quantify the ingredients of the recipe: 1 egg; 4 tablespoons of powdered milk; 3 tablespoons of oil; 2 level tablespoons of powdered chocolate; 4 level tablespoons of sugar; 4 level tablespoons of wheat flour and e 1 level coffee spoon of baking powder. Mix everything in a cup until it turns into a homogeneous dough and bake it for 3 minutes.

A remark that can be made about this recipe is that the cook had a similar attitude to that of the teacher who talked about the history of measurements at the beginning of the video: “using parts of the body as a reference to measure length”. The cook, while using “kitchen utensils” to measure mass, volume, and capacity, could have faced the same problem that people from ancient times had before the International System of Units. Are all the spoons the same (regarding capacity)? What is a level spoon? How to measure half cup? [...].

<sup>7</sup> The measurement system taught in Brazilian schools is the International System of Units.

Towards the end of the video, the host interviews an artisan that teaches us how to make a gift box. In this activity, she works with length measurement, but using the International System of Units as a reference this time. The artisan introduces the necessary material for the activity of making the little box (ruler, pencil, glue, scissors, ribbon, and cardboard) and shows the length measures used for this piece of art.

“Measure an internal square of 11 cm X 11 cm (at this point, there was a mismatch between the audio and the image, because, while she refers to the measure of the side of the square, the image shows the measure of the diagonal of the square, as can be noted in the video at 4min49s), and 19 cm for the bigger square, leaving a 4 cm-edge to make the sides of the box.”

For the lid, she calls our attention to the fact that it should be slightly bigger (11,5 cm for the said, that is, 0,5 cm bigger than the box) and the edge a little smaller (3 cm). Again, a minor mismatch can be noticed (audio  $\times$  image — side  $\times$  diagonal — between 5:00 and 5:05), but this does not affect the value of the work. About a few mistakes such as this one, we will discuss a little further ahead when presenting the video “How fishmongers survived in the XIX century”. For example, saying that the lid should be “five centimeters” bigger instead of 5 millimeters (between 5:10 and 5:15) for the lid to fit better does not imply that the authors did not know the difference between centimeters and millimeters. These are minor mistakes, as some others, such as typos or mistakes in their speeches, can be found in texts or lectures.

#### 4 “Sine Function”<sup>8</sup> Video — High School<sup>9</sup>

From High School students, we have the Sine Function Video.

*Three young students, who are very worried about not having understood the concepts underlying the trigonometric functions, seek help from a friend. In order to help the friends study such function, this friend encouraged them to study and learn the topic in an **unconventional** way. The text is a musical parody ‘Cheguei, função seno’.* (Description of the video by the authors, bolded emphasis added).

Teacher Sandra, responsible for the video, has been developing teaching and learning projects involving Art and Technologies since 2006, what she calls “Math at all times, with a set of instruments to work with teaching and learning. So, we use acting, music, dance, and the video is just one item of this project” (Comment by teacher Sandra in the round of conversation).

We would like to add a comment related to the word “conventional” used by the authors in the description of the video. In the Portuguese Dictionary (*Dicionário Brasileiro da Língua Portuguesa Michaelis*)<sup>10</sup>, the word **conventional** is introduced as: “related or resulting of a convention; according to the social conventions; consolidated by use; normalized, standardized; that lacks naturality because is a result of mere convention; artificial, fake, insincere”. In that sense, the “conventional” way of learning and teaching is what Santos (2016) names as traditional pedagogy.

What the authors present in the video is called a parody, a teaching and learning manner that is not conventional at all. Therefore, before we continue with the description of the video, we will talk about this literary genre that dates back from the XVI century.

<sup>8</sup> Own translation of “Função Seno”.

<sup>9</sup> Available on: <https://youtu.be/7lisTdlAyXM>. Accessed on: Feb 26, 2023

<sup>10</sup> Available on: <https://michaelis.uol.com.br/moderno-portugues/busca/portugues-brasileiro/convensional>. Accessed on: May 26, 2022.

the parody is a re-reading of an existing work, giving it a comic character by the changes made. This redefinition can be made in visual or written works, such as poems, movies, and songs. Usually, the author of the parody makes use of irony and mockery in order to make the alterations. The works chosen to be parodied are usually the ones that have a status of well-established and valued works. There is no adaptation of the original work in a new context, presenting it in a more relaxed way. The parodies are commonly used to discuss polemic subjects more informally and with less tension. (Significado, 2022, online)

The authors parodied a very popular song (Cheguei, by Ludmilla) among teenagers at that time (we are talking about the year of 2019). It is a happy and upbeat song. By the way, the lyrics (literature) was not the only thing to be adapted to contain the Math topics, there was also an adaptation to the original official choreography<sup>11</sup>. Note that parodying is not an easy task. It takes a well-known song (Cheguei), a relevant topic (the study of trigonometric functions), humor, and a good production to re-signify the text (in this case, the lyrics). This is what the authors said about the work:

*It was funny because it came to our minds. We went ahead and tried to fit it with the lyrics. It was really cool because it just flowed, you know? It was something that fit just beautifully. We sometimes see parodies that are weird. There was even a part where we chanted, we used our voices in a way that it would fit. [...] We were having some difficulties in getting the rhythm right in some parts. [...] Then we did (what we did) and it worked. (Comments by the students in the round of conversation).*

It was interesting to note the way in which they could synchronize so many elements of language and art to communicate math ideas in the video. They used graphics on the black board with different colors to add contrast; the song (parody) was in sync with the content on the board and with the subtitles, and the choreography reproducing, along with the dance, the behavior (movement) of the graph and the trigonometric cycle of the sine function, as can be seen in the video (0min36s to 1min).

Among the characteristics of the video, the use of digital technologies to produce knowledge and the use of hybrid language (verbal and non-verbal) to communicate ideas are aspects that stand out. “In the scope of mediatic art, works made with technological mediation in the visual and audiovisual arts, literature, music, and performing arts can be found” (Machado, 2007, p. 8). We would like to highlight the presence of Art as an instrument that produces experiences, both of contemplation, and of strangeness — concepts approached by Dewey and Brecht.

*To emphasize (the work), we looked for artistic means to bring what we are, ... happy. [...] at our school they work a lot with arts, it is something very important there! In any piece of written work, instead of asking us to type and make a normal cover, they prefer us to come up with work that includes an artistic drawing, for example, something that you show the artistic part, so we have a lot of that. It was something that was already incorporated, and we only added ... the dance, the gestures that we made. (Comment of a student in the round of conversation).*

*The production of the video started as normal piece of schoolwork to be graded, school things like that. Later, the teacher introduced this project for us to participate in the video festival. It was really interesting because it is something in which we had never participated before. It is not normal for us to participate in school stuff with videos. [...] The first time When the teacher introduced the proposal in the classroom, she suggested that we made a video class with content for the other students to access. Making the videos, understanding the math content in a different and diverse way, and sharing the experience with the*

<sup>11</sup> Available on: <https://www.youtube.com/watch?v=RNVLCr-Y7rQ>. Accessed on: May 27, 2022.



*classmates*. (Comment by two students in the round of conversation).

Note that, in the students' comments, the video was regarded as an evaluative activity (schoolwork to be graded). In this activity, they went from being consumers of videos of the "class" type (studying by watching the video class is a common practice among the students) to being producers of videos (learning by doing). They also talk about sharing their production with their classmates so that they can also have some experience with the work presented. There was experience for the ones who produce the art object and for those who contemplate the object that was produced.

Being a piece of mediatic art, it is good to bear in mind that, according to Borba and Villarreal (2005), the knowledge produced by a collective of human and non-human beings, and, considering these "non-human beings" as the media, we understand that there is not a duality "humans" and "media" in this process. Both humans and media have the power of action in the production of knowledge. In the creative process of video-making, this relationship becomes evident.

About this relationship between Human-Beings-With-Media, the teacher talks about the prominence of the cell phone in the process of video-making: "The use of cell phone, for instance, which is forbidden in the classroom, was key, because everything was done on the cell phone, including the editing. So, the point is to know the equipment that is being used. The cell phone, sometimes, disrupts the class, but it also helps if it is put to good use" (Comment by teacher Sandra in the round of conversation). Supporting teacher Sandra's comments, Souto and Borba (2018, p. 3) propose the following criticism: "Even while experiencing the changes that the digital technologies impose in our lives, we are still rooted to a classroom culture that, either does not allow access to the Internet, or resists to it."

In most of the participants' comments in the round of conversation, the questions related to the technologies pop up with greater emphasis. However, in this video, the art is presented both as a having contemplative objective, and as having the objective to reflect on the topic and the way it was approached. There was a concern from the authors about presenting a "beautiful" artistic product and, at the same time, sharing math ideas in an "unconventional" way, with the potential to produce experiences in the spectators that would cause them surprise or even awkwardness towards the normal (or naturalized).

Let us see some of the math ideas that the authors presented in the video. The sine function is one of the trigonometric functions studied in High School. These functions are also called circular functions because they are related to the other loops in the trigonometric cycle, in which each real number is associated to a point of the circumference and its graph, which is called sinusoidal, as shown in the video (0min36s to 0min48s).

Since the video presents a study of the sine function only, the values that are of interest are highlighted in the ordinate axis  $(0, y)$ . "The vertical projections are the Y axis" (at 0min40s of the video). Noting that, since the trigonometric circle has a unit radius ( $r = 1$ ), the possible values for the sine, in this cycle, are greater than or equal to  $-1$  and less than or equal to  $1$ , that is, the image of the sine function can be represented by  $Im(f) = \{y \in R / -1 \leq y \leq 1\}$ , or even in an interval form  $[-1, 1]$ .

Towards the end, they say (sing) about the sine values of  $90^\circ$  and  $270^\circ$ ; from  $180^\circ$  and  $360^\circ \equiv 0^\circ$ . "Sine of ninety is one; two hundred and seventy is minus one; one hundred and eighty, three hundred and sixty, zero degree equals to zero" (Video — from 1min17s to 1min31s). In fact, they had made a more complete video. "So, we made a video class of about Twenty minutes. We explained the functions of the  $30^\circ$ ,  $45^\circ$  and  $60^\circ$  angles. We talked about

the fundamental relations, explained all about the sine function. To suit the duration of the video to Festival notice parameters (six minutes), a few parts were cut out” (Comment by a student in the round of conversation).

Besides adapting the math content and the art, they had to mobilize technical resources to suit their video to the guidelines of the said festival. Again, there is evidence of the relationship Humans-Beings-With-Media in the production of knowledge and exposure of results.

## 5 “How fishmongers survived in the XIX century” Video — Higher Education<sup>12</sup>

*The motivation to produce the video ‘How the fishmonger survived in the XIX century’ emerged from the difficulty found with the elementary school research, due to mistakes in simple calculations, caused by erroneous thinking by the students. In this video, we will show a seller taking advantage of the lack of knowledge of his client. (Description of the video by the authors).*

The authors, students of higher education, bring up an old pedagogical discussion in this video about Mathematics teaching practices: “the mistake”. Watching this video, if you are a teacher, it is impossible not to ask: What do I do about my students’ math errors when they make mistakes? What can this (the way I will approach this errors) contribute (or not) to their learning?

Although it is fictional work, the topic of the video is based on real facts: “This film depicts the thinking, even if wrong, of many Elementary School students. The perfect opportunity for the teacher to stimulate the investigation through these methods” (Video — from 5min46s to 5min56s).

The video makes use of silent film as its art. “[...] we made it based on Charles Chaplin, Modern Times. Our video is a silent film. Its main means of communication is the narrative, through the conversation that is displayed on the screen. It has no audio, just the background music” (Text2 – Comment by a student). This style (silent film) was popularized in the Whole world by Charles Chaplin (1889-1977), also known as his main character, “Little Tramp”. Considered the most famous film actor of silent films, Chaplin, besides acting, was a dancer, director, and producers of his films. According to Freitas (2020, online):

Since nobody could hear the actors, they started developing ways of conveying the necessary emoticons to the spectators. The pantomime, a technique inherited from the theater, was an important strategy that ended up becoming a synonym of silent film. It consists of expressive movements, that sometimes seem exaggerated, but communicate exactly by the gestures. Today, it is more associated with clowns and mime artists.

By adopting the “silent film” style, the video producers replaced the characters’ speech lines (oral verbal language) by gestures (non-verbal language) and by subtitles (written verbal language). They also made use of sound designs (sounds and background music), characteristics of multimodal communication. Note that, in silent films, the film, not only did not have the characters speech, but also did not have a soundtrack – initially, the background music was performed by musicians and the sound effects, by sound artists, all on stage, during the screening of the film.

Silent films made use of techniques that were very similar to ones of the Brechtian

<sup>12</sup> Available on: <https://youtu.be/lbK0QbirQvo>. Accessed on: Feb 26, 2023

theater. From this perspective, we will analyze, in this video, the evidence of how this art produced awkwardness about “math mistakes”, or “how these mistakes are treated” and how they suggest the mistakes could be used to favor of learning.

After these observations, the same math problem will be presented under the two points of view present in the video — it starts with a customer asking the fishmonger at his stand what the price of the fresh fish was, to what the fishmonger answers: *This fish costs 25 doubloons*.

The 20.000-reis doubloon was a golden coin minted in Brazil by the Casa da Moeda de Vila Rica (Minas Gerais) between 1724 and 1727 during the reign of Dom João V while Brazil was a colony of Portugal [...]. This amazing coin, considered the biggest coin of intrinsic value (value of the metal) that had ever been around the world, carried the imprint of 20.000 reis on the obverse, although its real value could reach 24.000 reis, a quarter of the equivalent price of a young woman slave [...] (Pierry, 2018, online).

This information is not present in the video or in the group interview. So, we searched the Internet something about the subject which can if not contribute to the interpretation of the data, at least enrich the previous knowledge, and bring about some reflection. The Brazilian currency in the XIX century was the “Reis” (Rs or \$). With four of these coins, it was possible to buy a young woman slave and, to buy the fish (price informed in the video), it took 25 of these coins. That reminded me of the “A carne” (The Meat) song (the cheapest meat in the market is the black meat<sup>13</sup>), composed by Seu Jorge, Marcelo Yuca and Wilson Capellette, interpreted by Elza Soares.

In the next scene, the customer asks if it is possible to pay in installments. At this point, the problem starts to be analyzed. “[...] we looked for way to satirize a situation in which the fishmonger takes advantage of the customer’s lack of math knowledge. [...] imagine a person, in the XIX century, using a credit card to pay for goods! [...]. We have made a comedy based on the mistakes that students make in the math classes and that the teachers find funny (Comment by a student in the round of conversation).

Domingues (2020) discusses the language of humor as a way of interpreting, creating, criticizing, and presenting discourses of the Society. In this case, for the video authors, as well as Domingues (2020, p. 246) considered, “humor was a “weapon” that was used to show a fun Mathematics, to escape what is traditional and to call attention” to a naturalized situation in the Math classroom. This is Brechtian and so are the moments in which the spectator becomes SpectActor.

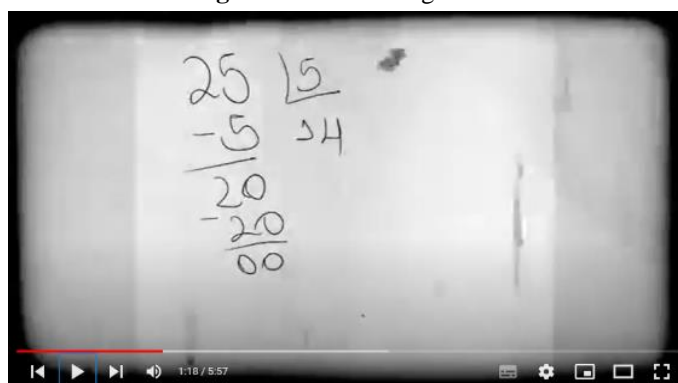
(1) Voyeur: [...] the aim is to (a) exploit ideas that provide mathematical surprises, in other words, ideas that aim at breaking stereotypes of some concepts, that show Mathematics as something associated with beauty and wonder; (b) communicate ideas in a clear and objective way but taking on possible tensions between the logical dimension of mathematical reasoning and the emerging subjective dimension with artistic languages. (2) Vicarious emotions: refer to the emotional moments in which we feel what the actors are feeling. [...]. (3) Visceral sensations: refer to the moments in which we do not feel exactly what the actors are feeling and start feeling our own sensations (Borba, Scucuglia & Gadanidis, 2014, p. 120).

About the math aesthetical experience, Gadanidis, Borba, Hughes and Lacerda (2016, p. 228) explain that these three pleasures are: “(1) the pleasure of examining the new,

<sup>13</sup> Videoclipe oficial disponível em: <https://www.youtube.com/watch?v=yktrUMoc1Xw>. Acesso em: 16 maio 2022

marvelous, and surprising in Mathematics; (2) the pleasure of experiencing emotional mathematical moments (being it our own, or indirectly from others); and (3) the visceral pleasure of feeling the mathematical beauty”. These sensations and emoticons go hand in hand with the techniques proposed in the Brecht didactical theater. See how the authors used this technique in the video sequence, the one in which the fishmonger, when answering the customer’s question about the possibility of paying in installments, says: “You can pay in five installments, interest-free, and each installment will be fourteen doubloons” (Video — from 0min40s to 0min44s). It seems weird, doesn’t it? Let us see how the (cunning) fishmonger justified himself to his customer (supposedly lacking mathematical knowledge), who was in doubt about the amount of the installments:

**Figure 1:** Division algorithm



**Source:** “How fishmongers survived in the XIX century” video screen.

**Step by step:**

25 divided by 5 equals 5;

5 multiplied by 5 equals 25;

25 minus 25 equals 0;

20 divided by 5 equals 4;

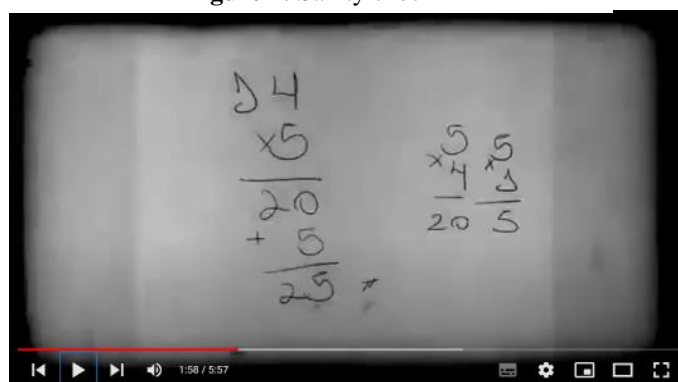
4 multiplied by 5 equals 20;

20 minus 20 equals zero.

Therefore, 25 divided by 5 equals 5.

Since the customer was still in doubt, the fishmonger proposed a “sanity check”:

**Figure 2:** Sanity check



**Source:** “How fishmongers survived in the XIX century” video screen.

Sanity check: 5 times 4 equals 20; 5 times 5 equals 25; 20 plus 5 equals 25. If 25 divided by 5 is 5 and 5 times 5 equals 25, the calculus is correct.

Note that, in Figure 1, except for the first step ( $25 \div 5 = 5$ ), everything else seems weird, but it is not wrong considering that 25 divided by 5 equals 5, but 20 remains. It is clear that, in that moment, the objective of the authors of the video was to call the spectator’s attention to the

absurdity of the situation (producing awkwardness — *voyeur*), but it is worth to reflect on the power relationship between the one who holds the knowledge (the fishmonger) over the one who does not (the customer), which turns the vicarious emotions into visceral sensations.

Let us consider that, to divide 25 1-real coins among 5 children, we start by giving 1 real to each one of them. We give them 5 reals total ( $5 \times 1 = 5$ ). There are still 20 1-real coins left ( $25 - 5 = 20$ ) to give to the 5 children.

As we continue, we divide the 20 coins left, giving 4 1-real coins to each of the 5 children, so that 20 coins are distributed ( $5 \times 4 = 20$ ), and no coins are left ( $20 - 20 = 0$ ).

This way, we can state that each of the 5 children got 5 reals, that is, 1 real in the first round and 4 more reals in the second round of the division. Thus,  $25 \div 5 = 5$ . Note that the fishmonger's (intending) mistake was to consider that  $25 \div 5 = 1$  in the first round, considering this 1 as a set of ten, and, by placing the 4 (units) to its right, the result is the number 14 (see Figure 1). In other words, he disregarded the positional value of the number 1.

Convinced that the calculus was correct, the customer pays with a credit card (another point of awkwardness, since credit cards did not exist in the XIX century) and goes home, deceived, but happy with his purchase. After five months<sup>14</sup>, the buyer goes back to the fish market, asking for his money back because the fish was rotten. Because he was "honest", the fishmonger gives the money back to his customer, but this time, calculating correctly: If  $5 \times 5 = 25$ . And if  $5 + 5 + 5 + 5 + 5 = 25$ , so:  $25 \div 5 = 5$ .

The "mistake" is a point of awkwardness in the educational environment. It is ignored or condemned in the teaching and learning process. Note that in the video, due to a lack of knowledge from the buyer and lack of honesty from the seller, the fishmonger sold a rotten product with a profit of 45 doubloons, since he got 70 ( $5 \times 14 = 70$ ) and paid only 25 ( $70 - 25 = 45$ ) back. With 5 more doubloons, it would be possible to buy 2 kilograms of fish or, with 3 more doubloons, 12 young women slaves.

## 6 A few remarks

The Common Core National Curriculum (BNCC), on the commitment to an integral education, states that "The contemporary society imposes an innovative and inclusive look at central issues of the education process: what to learn, why to learn, how to teach, how to teach, how to promote collaborative learning and how to **assess learning**" (BRASIL, 2018, p. 14, bolded emphasis added). Regarding the form of assessing learning, BNCC states that it is a question that results from a process related to actions such as

Developing and applying process or result formative assessment procedures that take into account the contexts and grounds for learning, taking such registers as a reference to improve the school's, teachers', and students' performance, and select produce, apply, and evaluate didactic and technological resources to support the teaching and learning process (Brasil, 2018, p. 17).

This document also emphasizes that it is imperative that the students take the Leading role, both as appreciators and artists, creators, and curators in performances, video art productions, animations, and other artistic and cultural manifestations and/or events carried out in the school and in other places, making use of conventional, alternative, and digital materials, instruments, and resources in different media and technologies (Brasil, 2018).

<sup>14</sup> Apparently, at that time, there was no time limit to claim the exchange of the product or a refund.

In that regard, one of the questions observed in the research participants' comments was the potentiality of video usage as a means of production process and use in the classroom, as an assessment tool, and, parallel to that (the assessment), the careful consideration the mistake as a learning possibility.

According to the Law of National Education Bases and Guidelines — LDB, Law nº 9.394, of December 20th, 1996 — (Article 24, incise V, subparagraph A), the teaching staff are responsible for looking after the students' learning and checking their school performance. In that regard, the assessment must be continuous and cumulative, with the prevalence of qualitative aspects over the quantitative ones. Traditional assessment is qualifying and takes place from the corrective process, eliminating the student's subjectivity. Many times, assessment is confused with measurement, and, on top of analyzing just a small portion of the knowledge, it unties what the students remembers about what was taught and what they can do with what they learned. We could (should)

understanding school learning evaluation as a time-consuming act, inasmuch as the objective of evaluation is to diagnose and to include the student through many different means, in the course of satisfactory learning, that integrates all his or her life experiences (Luckesi, 1999, p. 173).

The evaluation that are mentioned by the participants goes in that Direction. Teacher Carla, for example, uses video production as a means of diagnostic evaluation. Her videos are inserted in a pedagogical practice of an assessment context of the student's current level of performance. Teacher Sandra uses class, texts, and video reports as instruments for evaluation. She states that the reports with the best notes are the videos' and that in order to reach the final product it is necessary to go through several stages, such as research, plot, recording, and editing. Teacher Sandro, on the other hand, used videos as the final activity of the course, but he did not associate the grade to the entry in the no festival. It was the subject's final activity. Towards the end, still about the production of videos, teacher Sandra closes by saying that "learning is a sweated over consequence, but fun".

All these examples of evaluation are way too far from the school routine, in which the correct answer is usually associated to a reward and the mistakes to punishment, as what would be natural. In other words, an assessment system based on grades and tests, focusing on the final result, disregarding the process used by the student to reach such results. In the traditional system of school assessment, the act of evaluating, more often than not, comes dissociated from the act of teaching (and learning). The evaluations structured as such aim at classifying, quantifying, and many times (and because of that), excluding.

As discussed, the participants said that they use video production as an assessment resource. This resource focuses on learning and not only on correct answers (reward) or incorrect answers (punishment), or classifying, selecting, passing, or failing the school year. The assessment model that also makes use of videos as an instrument of evaluation is, in our understanding, fairer, because it allows students to express themselves in multiple forms and encourages them to research on top of producing reflection with the use of art in their aesthetic experiences and to develop their digital skills.

In conclusion (of the article, but not the discussions on the topic), we are going to reflect on what Dewey called, in his study, the aesthetical experience with an example. You can look at a flower and contemplate its "beauty". Its shape, color, perfume... but if you want to understand the beauty of the flower, it is necessary to know it. Why does it have this color? Why does it blossom in that period of the year? What makes it exhale that perfume? Why does it

only exist in that region? What is the relationship of this flower with the dirt, the insects, and the birds? Understanding art as an experience transcends the act of observing beauty just for pleasure, to understand the greatness and the complexity of beauty. Brecht's theory, in its didactic function, invites the spectator to this understanding through wondering, through what presents itself as natural, and he realizes that the rule can be improved (or replaced by another one) and that (almost) everything in society can (and sometimes must) be transformed.

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