

Free-choice teaching: how YouTube presents a new kind of teacher

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Abstract: This study presents a characterization of YouTube website (<http://www.youtube.com>) as a venue for informal science teaching and learning, as well as some advance in its definition. A significant portion of users spend time on YouTube watching potentially educational videos, why it happens and what leads people to produce them was investigated. Interviews with three producers of educational YouTube videos were conducted and from the analysis it was found that these videos producers have free-choice to decide what to teach, as opposed to a regular teacher, who has a curriculum to manage. This producer, named as a "teacher who teaches by free-choice" has less restriction on what to teach, which establishes a different relationship to knowledge and to the apprentices, mostly based on interest. It was possible to create an analogy to the teaching system presented by Chevallard (2005), illustrating the relationship between this "teacher who teaches by free-choice", the "informal learner" and the "knowledge". This system is a specific case of a general learning venue, which consists in a learner, some knowledge and a source of knowledge, along with their relationships. This idea must be put to the test by other investigations, in order to be shown valid.

Keywords: science teaching, free-choice teaching, informal education, YouTube, web 2.0.

Resumo: O presente estudo apresenta uma caracterização do site YouTube (<http://www.youtube.com>) como uma configuração de ensino e aprendizagem, assim como um certo avanço em sua definição. Uma quantidade significativa de usuários gasta tempo no YouTube assistindo vídeos potencialmente educacionais, o porquê isso acontece e o que leva pessoas a os produzirem foi investigado. Foram conduzidas entrevistas com três produtores de vídeos educacionais para o YouTube e a partir de suas análises foi observado que estes produtores têm livre escolha para decidir o que ensinar, em oposição a um professor tradicional, que tem um programa a cumprir. Este produtor, chamado de "professor que ensina por livre escolha", tem menos restrições sobre o que ensinar, o que estabelece uma relação com o saber e com o aprendiz diferente, baseada majoritariamente no interesse. Foi possível criar uma analogia com o sistema didático apresentado por Chevallard (2005), ilustrando a relação entre este "professor que ensina por livre escolha", o "aprendiz informal" e o "conhecimento". Este sistema é um caso específico de uma configuração de aprendizagem geral, que consiste em um aprendiz, algum saber e uma

fonte de saber, além de suas relações. Essa ideia deve ser testada por outras investigações, para se mostrar válida.

Palavras-chave: ensino de ciências, ensino por livre escolha, educação informal, YouTube, web 2.0.

Introduction

Teachers in several places of the world work hard to develop and maintain interest in science among their students. By the point of view of many students, science does not seem as attractive as teachers would like it to be.

Carl Rogers (1969) says: "human beings have a natural potentiality for learning. They are curious about their world, until and unless this curiosity is blunted by their experience in our educational system". This curiosity about the world is the trigger for interest in science, and if Rogers is correct, our educational system is working against itself, once its goal is to teach and its students in general does not want to learn.

Parallel to it there is a modality of science teaching and communicating that is in full rise and has each time more attention from the youth: YouTube science videos. Some YouTube Science channels have tens of millions of subscribers (users that follow that specific channel's videos) and several videos have tens of millions of views each. Different kind of people watch them and for different reasons, but it is certain that people are learning science through YouTube.

Understanding how science is taught in these videos may help the formal education to improve its efficiency in teaching science by improving the interest in science of the students. For that, it is asked: how is YouTube understood as a venue for science learning? Why the relationship to knowledge in these contexts (school and YouTube) are different from each other?

For naming purposes, we start by adopting the types of education described by Colley, Hodkinson and Malcolm (2002), from the European Commission Communication:

Formal learning: learning typically provided by an education or training institution, structured (in terms of learning objectives, learning time or learning support) and leading to certification. Formal learning is intentional from the learner's perspective.

Non-formal learning: learning that is not provided by an education or training institution and typically does not lead to certification. It is, however, structured (in terms of learning objectives, learning time or learning support). Non-formal learning is intentional from the learner's perspective.

Informal learning: learning resulting from daily life activities related to work, family or leisure. It is not structured (in terms of learning objectives, learning time or learning support) and typically does not lead to certification. Informal learning may be intentional but in most cases it is non-intentional (or "incidental"/ random).

Free-choice learning

Learning is an action that happens all the time, throughout our entire lives. It may happen at school, but most of the learning occurs outside of it, in our daily lives (Falk, 2005; Falk and Dierking, 2002; McCombs and Whisler, 1989; National Research Council, 2009). Alternatively to the usage of "formal/non-formal/informal" learning categories, Falk (2005) suggests a more embracing term: free-choice learning.

The author defines free-choice learning as "the type of learning that occurs when individuals exercise significant choice and control over their learning" (Falk, 2005, p.270). Still defining it, Falk states:

The free-choice learning generally occurs outside the school. It refers to the type of self-regulated learning that occurs daily in environments such as national parks, museums of history and science, zoos and aquariums, in community organizations, and through the use of print and electronic media, including the internet. (Falk, 2005, p.270)

Falk justifies the use of the term saying it differs from learning in informal environments, since informal learning does not necessarily (although most of the time) occurs voluntarily organized by the apprentice and at the pace he establishes (actually, informal learning can happen even without the awareness of the apprentice, as when one learns while having fun or talking to someone). It is also possible for the informal learning to happen (save the appropriate proportions) in formal educational venues, when the apprentice takes an active role in the process of learning, overriding external motivations.

The term "free-choice learning" encompasses the social character of this learning, because the learner not only chooses what to learn, but where and with whom. In summary, the term is useful to characterize the nature of learning, from the apprentice's perspective, which is his voice in the process, in its most different settings (in opposition to the formal/non-formal/informal learning, which designates basically where it happens) (Falk, 2005).

As the science learning outside the school becomes more relevant in everyday lives of youngsters and adults, the idea of the free-choice learning also becomes in need of attention. Dierking declares about the importance of it:

Science and technology learning is an important part of this educational shift. People engage in science and technology learning every day, across their life spans – at home, at work, and out in the world; much of this is free-choice learning. As we strive to develop science interest, knowledge, and understanding worldwide, we need to be aware of the vast number of ways, ages, and places in which a person learns science across their lifetime. (Dierking, 2005, p. 146)

Furthermore, people engage lifelong learning of science more by free-choice than they do at school or workplace. This learning happens by curiosity or even some personal crisis, such as an ill relative (Falk et al., 2007). It happens in people's leisure time, rather than at school, when and

about what the individual wants or needs, rather than when the educational system requires and about what a teacher (or a school council) judges important to learn.

School could instead provide a conceptual foundation which can develop the interest in science, which could be explored by the individuals in order to engage lifelong learning of science (Falk et al., 2007). For that matter, school must consider how it treats science education and society must acknowledge the non-formal/informal learning of science as a vital part of science education.

A leaning venue

The idea of learning venue has been shown to be a useful concept for understanding the various educational environments through which we learn life-long, life-wide and life-deep, as to characterize more adequately the differences and similarities between the formal, non-formal and informal education (Arruda et al, 2013). The National Research Council (2009) divides informal environments in three different venues: Everyday Settings and Family Activities, Science Learning in Designed Settings and Programs for the Young and Old.

Still, the term learning venue can be employed to designate all the possibilities of learning environments, virtual or physical, whether formal, informal or non-formal. To define it as a model to be applied in various settings, we begin from what Chevallard (2005) denotes as the didactic system for the mathematical teaching.

Chevallard postulates, for the didactics of mathematics, the existence of a knowable object, "preexisting and regardless of our intentions and endowed with a necessity of an own determinism" named didactic system (Chevallard, 2005, p. 14-15). This system, shown in Figure 1, is a structure consisting of three "places", "T" (the teacher), "S" (the student) and "K" (the knowledge), and its inter-relations, "as it happens in each year" (Chevallard, 2005, p. 15 and 26):

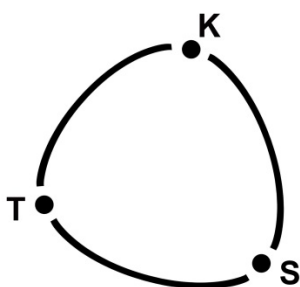


Figure 1.- Chevallard's didactic system (Source: Reproduction/Chevallard, 2005).

Chevallard clearly express that the knowledge in the didactic system is not the "wise knowledge" (the one produced by research), but a "deformed" one, "exiled from its origins and separated from its historical production" (ibid, p. 18), the "taught knowledge". Another important feature of the educational system is that it is open to the exterior, which is formed initially

by the strictu sensu education system, which contains various didactic systems for the different knowledge covered in a classroom, with its different teachers and different students. Consists of "a diverse set of structural devices that allows the didactic functioning and which intervenes in it at various levels" (ibid, p. 27). That, in turn, is immersed in a social Environment.

Immediately outside the educational system, the author calls "Noosphere" the instance the main didactic working stations occupies, that manage these relationships and connects the educational system with the outermost layer (the "Environment"). It is in this sphere that the practical discussions of how to improve education, how to proceed when something wrong in the teaching system occurs and how to apply new standards the classroom. "In the Noosphere, the representatives of the educational system meet, directly or indirectly, with the representatives of society" (Chevallard, 2005, p. 28). Figure 2, below, represents the education system and its social surroundings.

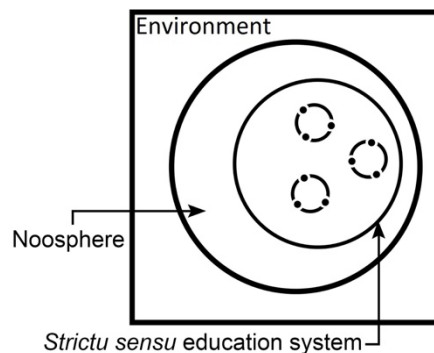


Figure 2.- Didactic system's surroundings (Source: Reproduction/Chevallard, 2005).

The didactic system, however, can be considered as a particular form of a more general model of relationship to knowledge, expressed by the figure below:

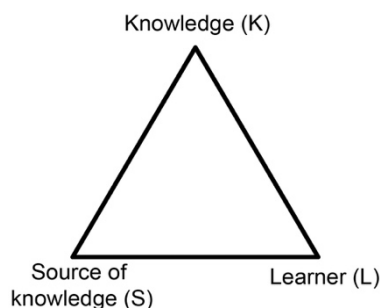


Figure 3.- A learning venue (Source: The author/Adapted from Arruda and Passos, 2015).

Let's call this figure "learning venue", where the components occupying the vertices are the following:

The learner "L" represents the subject who learns. It is the locus where the learning occurs. No one can learn for him or her. We are interested then in how she or he learns, with whom learns, if likes to learn, if identifies himself or herself as a learner, etc.;

The knowledge "K" is the knowledge to be learned, as defined by Chevallard;

The source of knowledge "S" can be a person or a group of people (a teacher, a monitor, a student, a community); an actual object (a book, a magazine, a newspaper); a mental object or sensory impression (an idea, an image, a sound); a digital platform (a website, a social network); an activity; an interpersonal relationship; etc. The source is independent of the subject who learns and can be objective or subjective (Arruda and Passos, 2015, p.11).

It is important to note that the learning venue is a structure, defined by three "places" – L, K and S – and the relation to each other.

The kind of source (of knowledge) defines the learning venue. But the kind of source is not arbitrarily set. It depends on the environment where the structure is located. In the case of formal education it is embedded in what Chevallard called Noosphere. But each venue would have its own "Noosphere", its instance of thought. The Noosphere defines how the knowledge circulates in the venue, defining whether the learning will be more or less free (Arruda and Passos, 2015).

YouTube

YouTube is a video repository founded in February 2005 (according to YouTube itself, in its "about" page) by three former employees of the e-commerce business PayPal, in which users could upload, publish and watch videos by streaming (Burgess and Green, 2009). Its social character made it pleasant among internet users and nowadays users can subscribe into other user's channels in order to receive their updates as long as they happen, as a "video feed". The number of subscriptions to a channel, together with the amount of views and comments in each video are a good indicator of the relevance the channel within the YouTube's universe.

Science-related themes are quite as old as YouTube itself, and the first big channel with a science approach was created by Salman Khan in 2006 (<http://www.youtube.com/khanacademy>), in order to help his relatives and eventually other students to learn mathematics, as said in his TED's (Technology, Entertainment and Design; a non-profit organization which communicates ideas they think worth spreading through small in conferences about almost any subject) speech in 2011. Nowadays, there are plenty of YouTube channels which the main subject is science, with some of them being significantly relevant on YouTube in matter of subscribers and views. Many science videos on YouTube have more than ten million views each (two good examples are Vsauce1: <http://www.youtube.com/Vsauce> and Veritasium: <http://www.youtube.com/Veritasium>, each has several videos with over 10

million views), which suggests that there are many of people interested in science apart from the formal educational context.

The internet in general is a new venue for the science learning and the development of interest in science (Falk, Storksdieck e Dierking, 2007; Jones and Stein, 2005, Kraap and Prenzel, 2011). Its role in the science learning is yet to be fully understood, and to contribute with this understanding is one of the objectives of this paper, by the characterization of YouTube as a learning venue.

Several researches discuss the role YouTube (or other social media and Web 2.0 resources) can play in formal education (e.g. Berk, 2009; Bull et al., 2008; Dabbagh and Kitsantas, 2012; Duffy, 2008). These Studies often bring reports or suggestions on how YouTube has been or can be used in classroom (as an insertion of an informal tool in a formal context). However, few studies discuss it in a pure informal context, such as when one watches an educational video at home without any explicit relation to school. For example, Tan (2013) describes some aspects of informal science learning in YouTube, such as the exploratory character and how it is connected to the learner's online community.

Context and methodology

This paper originates from the long notice from the authors and others teachers that science related topics doesn't seem interesting to students in formal educational context in Brazil, but a great amount of the students knows and likes to watch YouTube science related videos.

For this investigation, three semi-structured interviews were conducted with different YouTube video producers, one from an USA's educational channel and two from Brazilian's educational channels. Exceptionally, for the sake of understanding and contextualizing the interviewees' speech, their names will not be suppressed. Their authorization to be done so was asked in the beginning of the interviews, and the transcription's excerpts used in this paper were submitted for respective author's approval prior to the submission of this paper.

We present below the interviewee's names and their channels on YouTube.

Interviewee	Interview method	Country	Chanel(s) on YouTube
Henry Reich	via Skype	U.S.A.	http://www.youtube.com/minutephysics http://www.youtube.com/minuteearth
Iberê Thenório	Personal	Brazil	http://www.youtube.com/iberethenorio
Atila Iamarino	via Skype	Brazil	http://www.youtube.com/nerdologia

Figure 4. – List of interviewed YouTube producers.

Both Reich and Iamarino are science postgraduate producers, which indicates a fair knowledge of science. Thenório is a journalist by formation, and since 2008 produces videos about science and "how to" matters.

The respondent's speeches were interpreted trough qualitative content analysis, in order to observe the main strands (Mayring, 2014) of their

thoughts about science video producing. From a grounded theory approach of these speeches, four categories were inductively developed.

Since two of the interviews were conducted in Portuguese, when quoted, its excerpts were translated and will be presented in English.

Results

In the speeches of the respondents, some ideas about how they understand YouTube as a venue for science learning come out. The four categories relevant to the investigation emerged from the speeches are Interest, Aspects of teaching on YouTube, Community and Source of Informations. The categories are listed in decreasing order of number of coding units associated with each category (although this order does not necessarily reflect the priorities of the producers concerning video producing and science communication) and are described and justified as follows:

Interest

It became clear by the speeches of the YouTube producers that their interest in a subject plays the major role in the choice of the topics addressed in one's videos, since ~42% of the coding units address somehow to the interest, whether in teaching or in learning. Some excerpts illustrate well the importance of teaching for the producers:

So when you get the spirit that the learner has to feel more powerful after learn, you have another relationship with the teaching, you are teaching people because it can be really helpful to them in some form. For example, Manual do Mundo ("Manual do Mundo", Thenório's channel, means "World Manual" – added by the authors) has pranks, teaches how to make pranks, [...]. But what does it have to do with science? It has nothing to do with science, but it has to do with the idea that learning is really cool, and if you learn you'll be more powerful, you'll be able to do this with someone, and this I think it's not connected only with science, but education that learning is cool [...]. – Thenório

I always have loved, innately enjoyed teaching people things, helping people learn, whatever it may be, I don't really care what it is, I just love helping people learn things. [...] I decided to start making them mainly because when I was thinking about, if I were to make a YouTube channel, what would it be, the guys that I was working with, they make videos about stuff that they like, action and special effects, and I know a lot about science and I like teaching so it seemed natural to make videos about that. – Reich

Unlike other careers, the YouTube "teacher" (we chose to use the term "teacher" in its most fundamental form, someone who attempts to teach something) is not only free to choose to act as such, but also has freedom to teach what he judges interesting or convenient. Here, as in Wiki tools, the community regulates the quality of the uploaded content by giving higher views and ratings to those channels that are more attractive and at the same time criticizing in the designed area for comments and/or flagging as "not good" (through a button labeled "I dislike this" just below the video)

those who bring incorrect content or have no appeal. Iberê Thenório recounts his experience when eventually commits an error in his videos:

But there is an older audience, which accompanies, who really likes science, I see there are a lot of parents, teachers, college students, etc., that follows closely, and if I say something wrong the guy comes into action, but these guys participate less often, comment less, send less photos because it is the nature of adult, to participate less. – Thenório

It is also observed that the subject taught by the producers has different motivations, according to the proposal of the channel. Henry Reich explains that the topics covered in his main channel videos are those that concern him:

I make videos about whatever happens to catch my interest, that's really the key of keeping it interesting for me to make videos. The point is I'm not trying to teach a specific curriculum [...]. I don't have a specific agenda, in terms of what I want to teach. I'm not trying to teach people things; I'm trying to share the beauty and joy of science. [...]. So basically if I get excited or interested in some topic for a period of time I'll make some videos about it, [...] you know, it's kind of whatever I get excited about. – Reich

Atila Iamarino, who runs a channel in which the pop culture among youngsters serves as inspiration for the discussion of scientific matters, describes his motivations for the choice of topics as:

I really cannot explain what goes on in the head of people who watch, but what I try to establish in the video: I like comics, I like games, I like all the movies I'm discussing. I'll talk about them because I like, but the world is much richer with science. So it's really cool you speak of Wolverine, about his powers and how it would be if someone had claws. However, there's so much in there that would be much cooler if you understand how it works, you can imagine and unfold and see what it is, that put science that will only leave the thing cooler. [...] What I always try to show with the video is "cool, you like it and so do I, but come with me to see how it could be better, it could be richer". – Iamarino

Iberê Thenório, which has a channel not exclusively devoted to science, has a more fundamental concept of learning and its implications. From this vision, he shares with his audience different subjects related to science or not, that he judges interesting of being communicated:

A lot that I had done with my father, my grandfather, with my mother I wanted to teach, things I realized that other countries had a culture like ours, about what a kid learns, a boy learns, so these were things I wanted to teach. – Thenório

When you learn a magic trick, the magic has nothing to do with science, in general, a card magic trick, but you feel more powerful than you were before, you say "wow, I learned, I want to do it with my friends", that's the idea of Manual do Mundo, you'll learn something and you'll want to do it with your friends, you'll want to call your

friend, your cousin, your father, to do with them, this is the spirit, and it is much of the spirit of a grandfather teaching his grandchild, a parent teaching a child, a cousin teaching another cousin, you know, these things that happens in family or a kid teaching another at school, and the person says "wow, now that I know that I'm a much cooler person, after I know that". – Thenório

Aspects of teaching on YouTube

Teaching and learning relations on YouTube are different from the commonly experienced (in formal or non-formal situations) and understanding it influences the success of the YouTube producers. This is the second most addressed topic, where ~31% of the coding units reside. Some of these aspects become clear in the interviews. First, it is observed that there are no power relations between the teacher and the learner, since the learner has no obligation to learn nor is culturally forced to watch ~~in~~ the video, because at any time he can stop watching it. This characteristic differs from formal learning contexts, in which the teacher exercises direct influence on students (either imposing his ideas, or suggesting what to learn), but resembles science education through other media in the way of the choices that the apprentice is free to make (once the individual reads or watches a movie in general if he wants to).

Second, the method of feedback from YouTube is complex because it involves viewers comments, approvals/disapprovals, time of video watched, all of these provided by YouTube to the producer. Iberê Thenório describes this feedback dynamics:

You have many ways to give feedback. You can comment on YouTube, comment on the video on Facebook, comment on the video on the website, send email, send a private message on YouTube. – Thenório

It's something that didn't exist until a few years ago, is something completely new, this feedback. Before it, on television which is the feedback you have? The only feedback you have is the audience, and the audience, what is worse, the audience is sampling, and is a ridiculously small sampling, and other than that, the television will have some newspaper as feedback, what the critics are saying, some letters they receive and that's it. Dude, on YouTube, you know how many views your video had exactly, and how views per day, per hour, in each moment, how many "likes", how many comments, how many "added to Favorites", so you know well what it can be done [...]. – Thenório

When asked if the interest for science on YouTube comes from the proximity between the user and the producer, Henry Reich says:

Yeah, I think that it's true in two different ways, one is that the producers are accessible, much more so in terms of – you can leave comments on the videos, you can send people emails, tweets or Facebook messages or whatever it is, there's much more accessibility to the creators. But I think the other thing is that the creators are just regular people who started making videos. Somehow when you see

somebody on television or a movie, there's a lot more that goes on before they can be on the screen and what technology [...] has allowed people to do is just make regular people living their regular lives make videos and that's not just in science communication on YouTube, that's across all of YouTube [...]. I think that is one of the great things about YouTube, you know Destin of "Smarter Every Day" is an incredibly great example, he's a particularly special individual but he's just a regular guy, he's very talented in what he does and he's amazing, but he also... he lives with his family in Alabama and he makes science videos. That's connected in with the fact that people can make videos about what they're interested in, is you're just a regular person making videos about something you like. You seem like you're much more, you know, there with me in a same room, telling me something, that's the beauty of a lot of these things, whether it's Smarter Every Day or MinutePhysics is that they are – it seems very personal, one-on-one, like somebody's, you know, like your friend is just sharing some cool thing they heard with you. – Reich

About the reach of the YouTube videos, as compared to other media, Atila Iamarino, while talking about his video with the most views, about a bone fracture of a famous Mixed Martial Arts (MMA) fighter and the science behind this fracture, comments:

(It's the video with the most views) because a lot of people shared in MMA web groups. So, the guy who never, or better, a group that will hardly get on YouTube, see the channel name "Nerdologia" (which may be translated as "nerdology" – added by the authors) and get interested in watch some video in there or subscribe to the channel because it's "nerd" thing, but the video of the [fighter in question], the guy posted within the online group of the [fighter in question]. It's in his place, he can watch it, so I don't think the interest is even slightly different than it is in real life, for being on the internet, I just think that the availability of it, how it can be shared, is much broader. [...] Imagine if it were on pay TV. This video of [fighter in question] would be on Discovery channel, while the guy watching would be on ESPN, or wherever shows MMA. No videos of Discovery will be directed to him, but one can take the YouTube video and post within the community as well as a month before someone was picking up the video of cellulite (subject of a previous video – added by the authors) and posting on teenagers' websites. – Iamarino

Henry Reich also talks about this differential range:

But I think it is important to reach other people wherever they are, rather than force people to, for example, that's the kind of philosophy of having a Facebook page, a twitter, and an iTunes podcast, if people are Facebook users, you don't want them to have to become YouTube users, you don't force them outside their comfort zone. – Reich

These fragments of interviews make explicit some features of YouTube, such as how the videos have a different reach from other methods of teaching (e.g. formal education in schools, museums and even in everyday life). According to the producers, YouTube allows a more accurate feedback than in other forms of teaching, that viewers feel closer to the producers

and that the videos may get out of the YouTube site itself and go where the potentially interested people are.

Community

The respondents often addressed the community matter (~16% of the coding units). This category refers to the information exchange and referencing between the producers, along with the feeling they belong to a group that has a common objective.

Information from videos of other channels (educational too) is frequently used, sometimes transposing the information for the Portuguese speaking audience or reintroducing the data in a new way, using excerpts to present other applications or even performing partnerships between producers to enrich the content.

An example of a video in which a channel references another is the one in which Atila Iamarino cites the videos in partnership of Henry Reich and Derek Müller, in his video "The real powers of Magneto" (<https://youtu.be/EExCImj4Ls8>). In addition, the series of two videos Henry Reich did in partnership with Derek Müller on magnetism (<https://youtu.be/hFAOXdXZ5TM>) is an example of channels partnership.

Source of information

Depending on the producers of videos' degree and his target audience, he seeks scientific bases in different sources. The producers are concern of the accurateness of their content, and ~10% of the coding units address to how they manage to do content as accurate as they can. Some excerpts provide arguments in favor of the credibility of the producers:

I've also been evolving my research method, because in the beginning, I didn't know anything about Physics, I knew what I had studied for getting into college, [...] but now I search a lot in scientific papers, which is the same source that you (the researcher) research to do things, so I'm going to go in the article [...]. – Thenório

MinutePhysics is just me, and the research period is normally just me thinking for a while about things. Because I know a lot of Physics, normally if I have to check any facts or things I just quickly search on Wikipedia or search on the arXiv (www.arxiv.org) of Physics papers, or in Physics textbooks, just to make sure I'm not making mistakes. [...] So I don't have to go anywhere else for it, whereas the MinuteEarth videos, there's a team of people working on MinuteEarth, I don't do the research or the writing, I'll do a lot of revision and kind of forming or molding the story of those scripts, but I have a couple of writers who help out on doing the research and writing for that project, including my brother and father, they help out a little bit, so MinuteEarth is very different, and also the subject material is different, because it covers a much broader range of topics and dealing with things in Earth science and Biology and Ecology, Geophysics, where you really kind of do need to go and... unlike Physics where you can kind of just think it out and know the math and figure it out on paper, you actually have to go to research studies and figure out what people

have figured out based on actual observations of the world and of these processes. – Reich

Almost every YouTube channel has a target audience. Educational videos are no different and different sources of information are needed to reach the level of scientific formalism suitable for the target audience understands the message of the video.

It is important to point that as in any network with minimum content regulation, it is possible that producers publish videos with incorrect information that may lead to a misplaced learning. What is observed is that, in general, the community itself (as it is with wikis) flags the problems of some educational video, alerting less experienced viewers about the problems with that video.

Discussion

The excerpts show that interest is the central point of the teaching and learning on YouTube. But what this platform differs from other planned educational settings (both formal and non-formal) is that not only the learner demonstrates actively its free-choice to be entered in that situation, but also the “informal teacher” also expresses clearly his free-choice to teach.

The interviewees demonstrate the desire to teach what captivates them, what they deem to be interesting, as opposed to teachers in the formal educational system, that have a certain program to follow, and in some way have to account for it.

The concept of a learning venue can be useful to characterize YouTube as this setting for science teaching and learning. In analogy to the Chevallard's didactic system, a different one is observed on YouTube. In essence, the didactic system itself, resembles Chevallard's one, but we will name the three components as: “Informal Teacher” (T), “Learner” (L) and “Knowledge” (K). We added “Informal” as a modifier of the subject who teaches (since one does not need to be a formal teacher to teach on YouTube). The word “Learner” replaces “Student”, for a broader approach. As the knowledge may or may not *be the same one taught in the original (formal) system, we decided to keep its nomenclature*. Therefore, its representation becomes the one in Figure 5.

The union of the different didactic systems on YouTube, formerly called strictu sensu educational system is here a category among the numerous featured on YouTube (such as Music, Sports, Games, Movies, among others), namely, Science and Education category (www.youtube.com/channels/science_education). It is not rigid but flexible, since channels may or may not classify themselves inside this category according to the content of their videos.

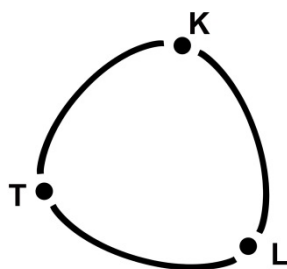


Figure 5.- YouTube's didactic system (Source: The Author).

What make the didactic system on YouTube different are their surroundings. The Environment is the YouTube itself, with its content restrictions, which for the Science teaching are practically irrelevant (unless the producer wishes to teach something illegal, such as how to make bombs or narcotics) and its algorithm that, from the video views, "likes", "shares" and comments, places it in more or less evidence than others.

Finally, the Noosphere practically does not exist in this informal didactic system, since no one regulates the interaction but the Informal Teacher and the Learner. The "instance of thought" here does not stipulate what must or must not be taught on YouTube, but works as a community where producers help each other to improve content. The lack of a regulating Noosphere implicates that the Informal Teacher now has freedom to teach what he wants (or chooses), or even just teach if he wants so.

We are faced now with a new kind of teacher, one who teaches by free-choice. Once he is not governed by a regulatory body which defines what to teach and what not to teach, this teacher is free to share with his learners that captivates him, what he judges important or interesting in Science (or in any other area), which naturally provides extra motivation, almost intrinsic to do so. This is well noted in the excerpt of the producer of MinutePhysics, Henry Reich:

The point is I'm not trying to teach a specific curriculum [...]. I don't have a specific agenda, in terms of what I want to teach. I'm not trying to teach people things; I'm trying to share the beauty and joy of science. And share the wonder, and allow people to appreciate and see new things and maybe try to understand some crazy things that they've heard about before. – Reich

When watching a Science video on YouTube, it is clear in the tone of their voice (and in the expression of those who actually appear in the video explaining something) that the "teachers who teach by free-choice" (the most correct terminology for this individual should be this one, since "being a teacher" is an act of free choice also in formal education, but not what to teach, ~~not~~) like what they are teaching, otherwise they would teach something else. And just as a student in a formal context may discourages himself when realizes the demotivation of his teacher, the passion with which these teachers teach motivates this learner, and if he does not feel motivated to continue watching what this teacher is teaching, he simply closes the video and watch another one that pleases him more.

Accepting YouTube as a venue for teaching and learning, the interest of those who teach and those who learn in that environment is the main aspect of this venue.

In this dynamic process, the teacher teaches the knowledge he wants and the learner seeks to learn what he wants, without any one of them being attached to a resume, an assessment or external pressures. Knowing this, we can restructure the Figure 3 and 2, naming the "Informal Teacher" now as "Teacher who teaches by free-choice" (however, the figure remains similar visually), eliminating the Noosphere in Figure 2 and changing nomenclatures of the surroundings (Figure 6):

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Figure 6. - YouTube's didactic system Surroundings (Source: The Author).

The sharing of knowledge becomes the goal of these teachers who teach by free-choice, as they have a scientific knowledge that they are pleased to share and, from this, they generate material communicating this knowledge, but they do not deliver it directly to a recipient, as in formal education (in which the teacher teaches directly to their students). Instead, this teacher from YouTube just assumes an apprentice, without a prior knowledge of him.

The fate of this video is highly uncertain because it depends on what audience shares it, in which social networks this video becomes available, in which other videos it will be indexed as a "related video". In short, the knowledge on YouTube is not addressed to someone or a specific group, but is shared throughout YouTube (and other websites, by the YouTube embed videos) with who wants to receive it and who eventually come across and is willing to learn from it.

The difference between YouTube and school is that the school in general does not allow choice neither by the teacher nor the student (in terms of what to learn, since there is a curriculum to be taught/learned), but YouTube permits a choice of both what to teach and what to learn. The relationship to knowledge in school is defined a priori, but the relationship to knowledge on YouTube stands on freedom of choice, it depends on the desire of the learner to learn what he wants.

In a more general approach, the didactic system as presented by Chevallard can be understood as a learning venue that represents a standard classroom. It is a system all tied up, where the vertices are predetermined (hence represents the formal learning): "T" does not teach what he wants, "L" does not learn what he wants and "K" is not any knowledge, but the one defined by the curriculum.

For the presented learning venue, we observe that the source of knowledge is the YouTube video, the knowledge is the one discussed in the video and the learner is anyone who is willing to watch and learn from it.

However, to talk about a general learning venue is necessary to bring the idea of relationship to knowledge (or to the learning) and desire to knowledge (or to the learning). Charlot (1997) defines this relation as the

relation of the subject with the world, with himself and with the others. From that, it is possible to look for how and why the learner seeks (or not) some specific knowledge, whether scientific or not.

For Charlot, each learning event has an outer sphere (the Noosphere) in which the learner gets involved with the environment around him, with himself as a subject in construction that may or may not need that knowledge and with other people that can influence him towards the learning or against it. In short, a learning venue is not made of only a set of objects that exchange meanings, but also of the different relationships the learner has with the world, himself and the others.

This paper brings the first ideas about how to understand different learning contexts independently of its formality degree, trying to reduce any learning event, whether formal, non-formal, informal, free-choice driven or not to a set of relations. Furthermore, this model pays more attention to the relationship to knowledge of the learner, in order to understand and improve the relations of interest from learners towards the knowledge.

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