WHERE TO LEARN MATH? A STUDY OF ACCESS TO AN EDUCATIONAL CHANNEL ON YOUTUBE

Valdinei Cezar Cardoso
vccardoso@uem.br

Lilian Akemi Kato
lakato@uem.br

Universidade Estadual de Maringá,

Samuel Rocha de Oliveira
samuel@ime.unicamp.br

Universidade Estadual de Campinas

ABSTRACT

This article presents the results of a study whose data were collected from 2009 to 2012, about the users of a YouTube channel, aimed at teaching, and at the scientific dissemination of Mathematics. The goal of the study was to understand the reasons why different users consult the channel, as well as the themes looked up by them. The methodological approach adopted was a qualitative interpretative one. The results show that videos related to Linear Algebra are the most popular ones and the number of accesses to the channel increases, especially in periods of school evaluations, indicating that these videos work as support for students to learn or to complement their studies.

Keywords: Digital Video; YouTube; Teaching Mathematics; Technological devices; Learning Mathematics.

RESUMO

Este artigo apresenta os resultados de um estudo, cujos dados foram coletados no período de 2009 a 2012, acerca dos usuários de um canal do YouTube, voltado à divulgação científica de Matemática. O objetivo do estudo foi compreender os motivos que levam diferentes usuários a consultarem o canal, bem como os assuntos mais procurados por eles. A abordagem metodológica adotada foi a pesquisa qualitativa de natureza interpretativa. Os resultados mostram que os vídeos relacionados à Álgebra Linear são os mais procurados e a quantidade de acessos ao canal aumenta, principalmente, nos períodos de avaliações escolares, apontando que tais vídeos servem como suporte aos estudantes para aprender ou complementar seus estudos.

Palavras-chave: Vídeos Digitais; Youtube; Ensino de Matemática.

1. Introduction

The integration between information and communication technologies (ICT) to teaching situations is the theme for several researches, among which are: those that discuss the procedures to optimize the use of technological devices in the teaching context (Giannakos & Vlamos, 2013, p. 125); those that deal with the integration between the teaching environment and digital games and quizzes (Virvou, Katsionis & Manos 2005; Virvou & Katsionis, 2008); and those that investigate the use of

educational videos as teaching tools (Schineider, 2001) or synchronous or asynchronous classes through the Internet (Yunus, A. S. *et al.* 2006).

The use of the Internet for teaching, including e-learning and educational materials, has increased over the last years (Giannakos & Vlamos, 2013). And in order to meet this growing demand, several digital tools have been employed as a repository[1] for learning objects, among which are Moodle, View, Wiziq, Teleduc, Blackboard, digital libraries, webcasts, blogs, websites that offer applets and games, among others.

Such tools provide for the availability of a large number of educational materials that are accessed by the general public; however, the profile of such users is still unknown, as well as the purpose and the results from such interaction. According to Zhou & Xu (2007), introducing e-learning[2] to the traditional educational environment is a complex tool, since it demands from the teacher a pedagogical and technological background that allows him/her to integrate the technological resources to didactic objectives.

Even so, several institutions bet on the potentialities of the teaching possibility. The number of teaching institutions that offer contents through the Internet has been quickly increasing. An example of that is Coursera[3], which counts on over 69 partner universities and over 3.5 millions registered students.

In addition to the free courses offered by institutions, which have been widely looked for in the search for videos and didactic materials related to the most different areas of knowledge, websites such as youtube.com and learningtube.com have gained the interest of the public that looks for quick access to specific contents.

Particularly, in the educational sphere, accessing these websites most of the times makes it easier to get quick answers for school-related doubts, not to discuss the veracity of such information. This observation demands some questioning about the users of such websites and their intentions when accessing them: Learning? Studying? Clearing doubts? Gathering knowledge?

In that context, this study investigates: Who are the users and what do they look for in a certain channel on YouTube[4]?

For such, we analyzed the accesses to a YouTube channel created in 2008, whose first videos were made from translations into Portuguese from videos made in other languages. The initial purpose of the channel was to offer videos that would complement the printed didactic material for two groups of (Civil and Electric) Engineering students from the e-learning modality.

That happened because the abovementioned students were having difficulties to interpret the written material, which, in several cases, resulted in dropouts and a low approval index on the enrolled disciplines. With the intention of overcoming this problem, we noticed that the explicative videos on the contents suggested in these materials could collaborate for the learning process of these students.

[1] Internet address used to add and make available educational digital resources.
[2] Process through which the student learns through contents made available on the computer and/or the Internet and in which the teacher, if any, teaches from a remote location, using the Internet as the (synchronous or asynchronous) means of communication, and there may be intermediate face-to-face sessions.
[3] Coursera is an educational company that is partners with universities and organization worldwide to offer free online courses.
[4] A website that allows its users to load and share videos digitally.

Based on the studies by Mayer (2003), Mayer and Durso (1999), and Meira (1994), we considered that learning occurs, mainly, through the hearing and visual channels. In that sense, the authors indicate that, by studying the same contents over media that promote learning through both of these channels, students are more likely to success. Currently, the channel has approximately 1,000 videos available, 2.5 million views, and about a thousand followers.

By analyzing the accesses and some of the profiles from these users, the research indicated, among other information, that there is a great demand for Linear Algebra videos, within the context of the videos made available. In such videos, the most accessed subjects are those related to the operations involving matrices, determinants and elimination methods.

The information resulting from this study indicate the need for a broader and more rigorous study on the Mathematics educational videos that are accessed by the general public and may directly interfere in the school-related and academic mathematics teaching and learning process.
Theoretical foundation

2. Mayer's cognitive theory of multimedia learning

For Mayer (2009), multimedia learning is a change in knowledge attributed to experience. The learning act is understood as personal, and the cognitive changes involve reorganization and integration of knowledge.

Learning under this view is a change that occurs in the learner, and one reason for this change is the acquisition of experiences during the study of a particular subject. In our work, we seek to understand how digital videos can help students to act proactively in building the concept of function.

The cognitive theory of multimedia learning (CTML) takes the information processing system as being composed of two channels: the visual and the auditory ones. Each one has a limited processing capability and is primarily through these systems that people learn.

Mayer's CTML seeks to understand the potential of multimedia to promote learning. According to this theory, learning occurs more deeply if the ideas are expressed through words and images. In a manual activity, touch, smell and taste could be complementary channels for the learning, but the CTML is designed and tested only for the two senses of sight and hearing.

For Mayer (2003), the simple addition of images to narrated texts not always improves learning; for him, multimedia instruction goes beyond the simple verbal transmission of content; it must show step by step the concept being taught, with words that describe each step (printed or narrated) accompanied by illustrations that complement what is explained. Thus, Mayer (2003) says that "in an environment based on books, the external representations can include printed words and illustrations, both of which initially enter through the eyes. The student must select relevant aspects of the input images for further processing" (p. 4).

The same occurs in the environment based on digital educational videos: if the material is presented only in the visual channel or just the verbal one, the other one is ignored and learning may be impaired.

This loss occurs because words are more appropriate to present some types of materials, whereas images are best prescribed for others. Moreover, Mayer (2003) states that an environment of computer-based instruction must teach using spoken words, which are captured by the ears, and

animations, which are captured by the eyes, and this favors the student to select relevant aspects of the sounds and the images for further processing.

Mayer (2009) argues that technology should be used to expand the cognitive capacity, and it needs to be consistent with the manner of the functioning of the human mind. Thus, the computer emerges as an artifact of reference that can be used in teaching situations as a means of automation or as a motivator of argument, being the latter advocated as the most effective for learning.
The multimedia learning from the perspective of Clark, Nguyen and Sweller (2006) can occur through the acquisition of information, the strengthening of responses (stimulus-response theory) that are limited, or the construction of knowledge provided by the cognitive aid.

Precisely this last possibility of multimedia learning is the focus of our work, because, as stated by Mayer (2009), when watching a video related to a matter considered to be complex, people do not resort to videos for every unknown word; the tendency is to turn to prior knowledge about what is studied.

The goal of multimedia presentations is not only to provide information, but also to guide on how to process the information presented, how to mentally organize information, and how to relate it to prior knowledge. From these goals, this work seeks to understand how the videos contribute to the learning of mathematical concepts.

We agree with Mayer (2009) when he states that the learning goals are to understand and to remember. To evaluate the success rate in this context, transfer tests can be used, which would be the ability to apply a concept or a scheme learned from one context into another or into a close concept, with some, but not identical, similarities.

When the goal is to analyze what the students recall, retention tests are indicated, which can be about the recognition of information, as in most entrance exams, or about the exact measuring of what was memorized after the study of a certain subject; both are interested in the amount of knowledge retained.

An example of application of these tests is presented by Mayer (2009) in a study performed with three individuals. The first one was asked to read about a subject he/she was not motivated to learn. The second, who was willing to learn,was asked to read the same text; and finally, the third subject, who was also motivated to learn, was presented a multimedia consisting of a text shown on a computer screen, explaining some phenomena demonstrated in an animation.

The results of this study show that the first person, who was not motivated to learn, did not understand, nor could explain or apply what was learned in the text. The second person retained more information from the text, but did not know how to apply the knowledge from the text in related problems and had the same failure as the first in the applications of what they had studied. The third person understood the main concepts in the text, was able to generate creative solutions to the problems posed and showed significant knowledge about what he/she studied.

From these results, Mayer (2009) presented some suggestions on the integration between text and images in digital media. The first suggestion is that the text and the images emphasize the key ideas of the subject studied, being concise and without unnecessary detail. The images and texts showed must be relevant, practical and of easy viewing. Both texts and images should be understandable and close to the students' prior knowledge.

Mayer (2009) lists twelve principles, according to which learning, mediated by educational media, can be enhanced or hindered depending on the way that each video is produced.

Thinking about the best organization of these principles, Mayer (2009) organizes them into three groups: the first is called "principles for reducing extraneous processing" and includes the principles listed below:

P01- Coherence: people learn better when the use of extraneous words, pictures or sounds is minimized.

For Mayer and Durso (1999), students who read a passage explaining the steps to perform a particular task, in a clear and objective way, reached 50% more useful solutions on a subsequent solution of problems than students who only read some information with additional details included in the material.

P02 - Signaling: people learn better when some tips that highlight the main points of the material are added.

P03 - Redundancy: people learn better when media use graphics and narration than when using graphics, narration and written text on the screen, because, in the latter two, the channels (auditory and visual) are used simultaneously to present the same information.

P04 - Spatial Contiguity: People learn better when corresponding words and pictures are displayed next to each other and on the same page.

The great contribution of these principles is that they provide subsidies enabling us to understand that if corresponding figures and words can be processed in the memory at the same time, each being captured by a different channel, the construction of correspondence between their meanings can be fostered. And such fostering directly contributes to conceptual learning.

P05 - Temporal Contiguity: people learn better when corresponding words and pictures are presented simultaneously than when they are presented successively.

Mayer and Durso (1999) showed that students with high spatial ability are able to store the visual image in the working memory, and thus are more likely to benefit from contiguous presentation of words and images.

For them, students with high or low ability who have contact with multimedia explanations are more prepared to build two different mental representations - the verbal and visual ones - and establish relationships between them.

The second group of principles presented by Mayer (2009) is entitled “principles for managing essential processing”:

P06 - Segmenting: people learn better when an online lesson is presented in units than when it is presented in a continuous and uncut way.

P07 - Pretraining: people learn better with a multimedia lesson when they know the names and characteristics of the essential concepts.

P08 - Modality: people learn better from graphics and narration than with written texts and animations on the screen.

For Sweller (2005), the processing of knowledge by students requires great cognitive effort; if such requirement is too great, the student smay not be able to turn their attention to the selection, organization and integration of what has been studied. The result is the low retention, poor performance and the inability to transfer the concept studied to other situations, which, in the school environment, can result in low academic performance and superficial understanding of what is studied.

The third group of principles suggested by Mayer (2009) comprises the "principles for fostering generative processing", presented below:

P09 - Multimedia: people learn better from words and pictures than from words alone.

P10 - Personalization: people learn better from a multimedia lesson when words are in a conversational style rather than in a formal style.

P11 - Voice: People learn better when the narration in a multimedia lesson is spoken by a friendly human voice rather than a machine voice.

P12 - Image: people do not necessarily learn better from a multimedia lesson when voice on images is added to the screen.

The central idea advocated in these principles is that human learning is optimized when the teaching material presents information that can be captured by different senses, e.g. hearing and vision, simultaneously. Affective factors must also be taken into account when preparing an instructional material, since the personalization of the material approximates the student from what is taught.

3. Methodology and general procedure for data collection

The research methodology adopted in our study was initially constituted by a data collection on the v13dinei channel, using the YouTube Analytics[5] tool. From there, we selected data related to the following items: monthly views during the period from January 2009 to December 2012; amount of videos produced by subject; subjects discussed on the 10 most accessed videos from 2009 to 2012; and the rating of the public from the 10 countries that make most use of the channel, by gender and age range. We also selected at random some comments made on the channel, classifying into seven categories.

During the data collection, the data from 2008 and from 2013 were not considered. The first one because the channel was still during an implementation stage, and the last one because we still did not have the data from all months.

In this article, we show only data that correspond to the research objectives. These data were treated with the MS Excel 2010 software and qualitatively discussed with the purpose of understanding the objective of the study and answering to the research questions.

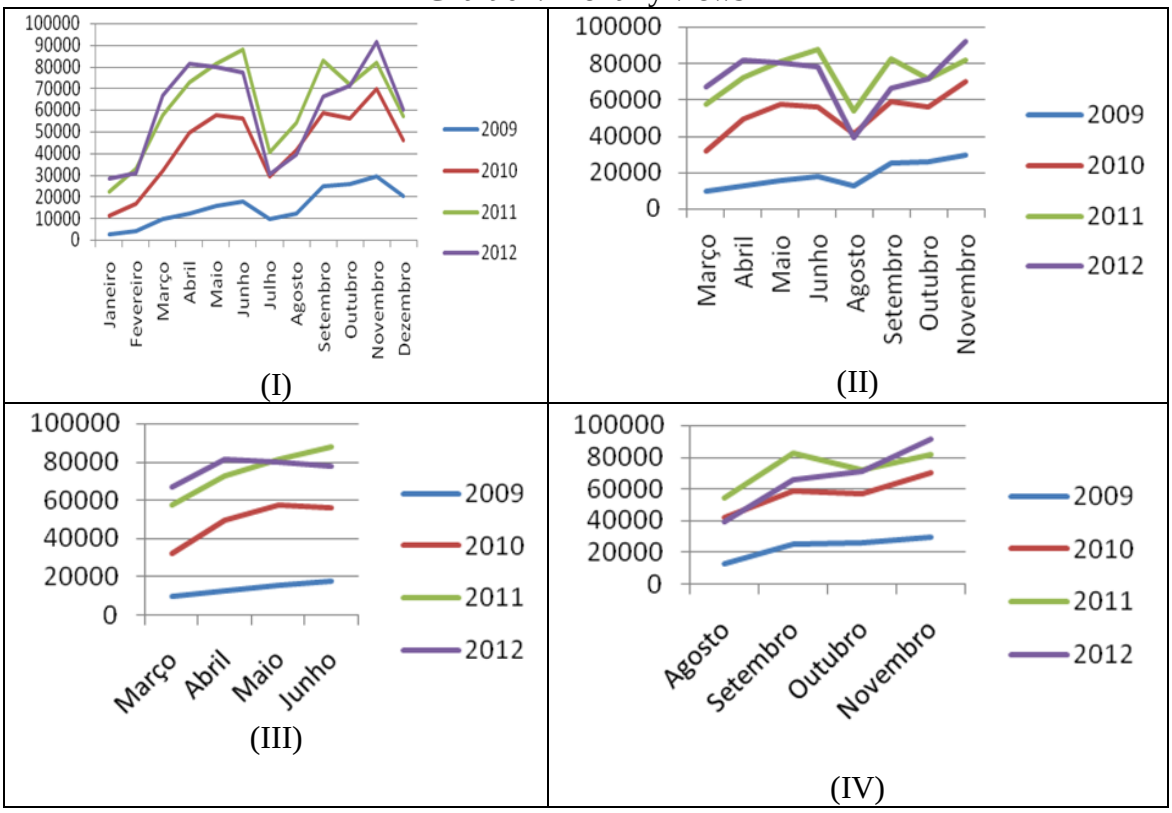
[5] This is a free service offered by Google, in which, after the users are enabled through a Google account and after they register to a website, receive a code , which must be entered on the registered page and, upon each view, access statistics are sent to the system and shown to the owner of the website.

4. Results and discussion

4.1 Monthly views during the period from January 2009 to December 2012

In Chart 01 (I), we show the number of monthly views of the videos on the v13dinei channel. During this period, it is possible to observe that the number of views increases along the years.

Chart 01: Monthly views



Source: www.youtube.com/v13dinei

(I) January, February, March, April, May, June, July, August, September, October, November, December
(II) March, April, May, June, July, August, September, October, November
(III) March, April, May, June
(IV) August, September, October, November

The number of views shown in Chart 01 (I) indicates a growing number of accesses that follows the Brazilian school year, in which the months from March to June and from August to November correspond to the class periods.

Another information from Chart 01 (III) and (IV) is the occurrence of two spikes in each semester, which shows that the search for the videos increased during the months of April, June, October and November. This information allows us to assume that there are possible relationships between the accesses to the channel and school-related activities like exam periods and bimester or semester closing periods.

In general, during the first semester, two exams are given in each discipline in average, one for each bimester. Chart 01 (III) shows that the views have two increase spikes, which may have been caused by the search for additional material by students that would help them during the exams preparation. The same occurs during the second school semester, in which we can notice two

increase spikes in the views – Chart 01 (IV) –, which also supports our hypothesis that the users of the channel turn to the videos as complementary material for their studies, and the search increases during the evaluation periods.

Such observation was also made by the Office of the Vice President for Undergraduate Studies from Universidade Estadual Paulista Júlio de Mesquita Filho (UNESP – Rio Claro) through an annual report from the Support Program for Calculus or Similar Disciplines of the year of 2012, which states that the search by students for the tutoring service is low during school semesters, and that it increases on the days prior to the exams, and that students from the night-time period do not have enough time to attend the tutoring service.

The data show that such factors contribute for accessing the material available in channel v13dinei. On the one hand, Chart 01 (I) shows that the access to the material increased during the same periods over the 4 years in which data were collected. On the other hand, the fact that the videos were available for free on the Internet may make it easier for students from the night-time period to access them, since these are students that usually work during the day, to review the contents studied during the regular courses.

The assumption that the increase on the views occurs at the same time than the school year indicates that the users of the channel use the videos as a complementary study material to what they already study in face-to-face or e-learning environments.

This is due to the new type of literature that the digital material, available online, provides the students, who are failing to stick just to written and printed material, to become immersive and visual readers (SANTAELLA, 2006), which is reinforced by Mayer (2009) to propose the principle of multimedia (P09), where he affirms that people learn better with words and pictures than just with words.

For Mayer (2009) and Bransford et al. (2000) the beginners on the study of some themes depend more on pictures than those that have a deep knowledge about what is being studied. That is why, according to the principle P02, the teacher's signaling of important points of theory to be taught can assist the learners to understand the most important points of what they are studying.

In this context, we infer that the video research by the students was motivated by the fact that the digital videos of the channel v13dinei answered, to a certain extent, the principle of segmentation (P06), allowing the quick access to and achievement of the concept of Linear Algebra.

In the next section, we will show a survey on the total of videos available in the v13dinei channel, classifying them by subject and number of views.

4.2 Amount of videos in the channel and number of views per subject

In Chart 01, we show all the videos from the channel v13dinei, sorting them per subject. From this classification, we may notice that the 844 videos from this channel are distributed as follows: Calculus I (24%), Basic Mathematics (23%), Linear Algebra (22%), Analytic Geometry (15%), Calculus II (14%), Propositional Logic (1%), and Statistics (1%).

Considering only the 10 most accessed videos during the period from January 2009 to December 2012, we noticed that the Linear Algebra (LA) videos represent between 60% and 80% of the total views, during the four years in which data were collected (Chart 02), even if the total amount of Calculus I, Basic Mathematic and LA videos is virtually the same.

That leads us to assume that the users of the channel prefer the LA material in comparison with the other subject.

Chart 02: Views per discipline, subject and year during the period from 2009 to 2012.

	Year of 2009		**Year of 2010**	
	Subject	**Views**	**Subject**	**Views**
Linear Algebra	Determinants	31118	Determinants	49874
	Elimination	12215	Elimination	21275
	Vectors	8607	Matrix Multiplication	15588
	Cramer's Rule	6272	Cramer's Rule	12315
	Invertible Matrix	9046	Invertible Matrix	13963
	Total	**62258**	**Total**	**113015**
Calculus I	Integrals	5763	Integrals	12317
	Derivatives	26365	Derivatives	53518
	Total	**32128**	**Total**	**65835**
	Year of 2011		**Year of 2012**	
	Subject	**Views**	**Subject**	**Views**
Linear Algebra	Matrix Multiplication	24234	Matrix Multiplication	50244
	Determinants	90257	Determinants	48487
	Elimination	31218	Elimination	34956
	-	-	Scalar and vector products	15273
	-	-	Operations with matrices	11333
	Cramer's Rule	13724	Cramer's Rule	12858
	Total	**159433**	**Total**	**173151**
Calculus I	Integrals	16268	Integrals	11724
	Derivatives	48081	-	-
	Total	**64349**	**Total**	**11724**
Basic Mathematics			Numerical Expressions	13572
	Algebraic Fractions	19113	Algebraic Fractions	13356
	Total	**19113**	**Total**	**26928**

Source: www.youtube.com/v13dinei

Chart 02 shows that, among the 10 most accessed videos during the period from 2009 to 2012, those related to LA are the ones with the most number of views, and the themes most searched for are: determinants, Cramer's rule, elimination, and operations involving matrices. Such subjects are

part of the programmatic content of the Brazilian high-school courses and are taught in undergraduate LA courses.

Although we have no information about the users of the videos and assuming that they are mostly undergraduate or high-school students, we may suppose that these videos are offering subsides for school tasks on the referred subject.

Having that in mind, there is the hypothesis that the high number of views on themes related to LA, in comparison, for example, with the number of views on Calculus I, occurs due to the fact that the number of students from high school or undergraduate courses have increased since 2007[6]. According to School Census 2009[7], the number of Brazilian students in High School is over 8 million, and students in undergraduate courses are approximately 6.7 million.

Since the most searched for topics in LA are part of the curricular program both for High School and the initial grades of the undergraduate courses in Exact Sciences, we inferred that the major difference in accessed related to LA themes, when compared to Calculus I, is caused by the greater demand for LA materials than for Calculus I materials.

Table 01 shows the total distribution of views of the 10 most accessed videos in this period and allows us to have a synthetic perspective on the preference of the users by subject.

Table 01: Percentage of views by subject for the 10 most accessed videos during each year.

	2009	**2010**	**2011**	**2012**
Linear Algebra	66%	63%	66%	82%
Calculus	34%	37%	26%	6%
Basic Mathematics	0	0	8%	13%

Source: www.youtube.com/v13dinei

According to Arcavi (2006), by studying contents that involve algebraic thinking, the students need initially to understand the symbols that are handled by them; then, they need to be able to handle these symbols and read them into more complex expressions. The next step is developing the ability to express ideas, using the studied symbols, selecting adequate symbolic representations and improving them when necessary. Finally, the students must develop the awareness that the symbols perform different roles in different contexts.

Bransford *et al.* (2000, p. 31) state that "understanding expertise is important because it provides insights into the nature of thinking and problem solving". In that sense, we assume that the LA videos may help students to understand the mathematical characters used by this discipline, since they show examples on how to handle symbols, in addition to situations in which they are integrated to more general ideas, which work as an example for students to understand the adequate representations and be able to improve them and apply them to what they are studying in their regular classes.

If the students realize that that which they find in the videos is similar to what is taught in the classroom, than they may review what was studied with the help of these media, which allow them to pause, advance to the points in which they are interested and also show how a LA teacher realizes, organizes and represents the concepts from the referred discipline.

[6] http://www.ibge.gov.br/brasil_em_sintese/
[7] http://www.brasil.gov.br/sobre/educacao/sistema-educacional/ensino-medio

Linear Algebra is characterized as a discipline that is present in practically all the courses related to Sciences and, as it is a discipline that demands a high level of abstraction, it has been causing a big number of repetition and dropouts in courses of graduation all over our country year after year, (CELESTINO, 2000).

Usually in Brazil, the institutions offer introduction courses of AL already in the first year of graduation. The students at this level are not, in general, prepared to study the concepts of abstract mathematics, like AL, because in basic Brazilian studies they rarely have contact with the concepts of this nature. This type of situation can be one of the catalysts on the search of students for digital videos of AL, who can watch them to understand the concepts inherent to this field of studies.

When they study at home, students choose what they want to study, emphasize those contents they find more difficult and manage their own time, studying only that what they do not completely understand during the classes; within this scenario, the educational digital video would be an extension of the regular classes (Bergmann & Sams, 2012).

In the next section, we will show and discuss some data that characterize the users of the channel v13dinei.

4.3 Categorizing the users of the channel

Figure 01 shows that 70% of the users of the channel are males, and 30% are females. Considering the sample from the 10 countries with the highest number of views, we observed that approximately 80% of the accesses are from Brazilian users (Table 02).

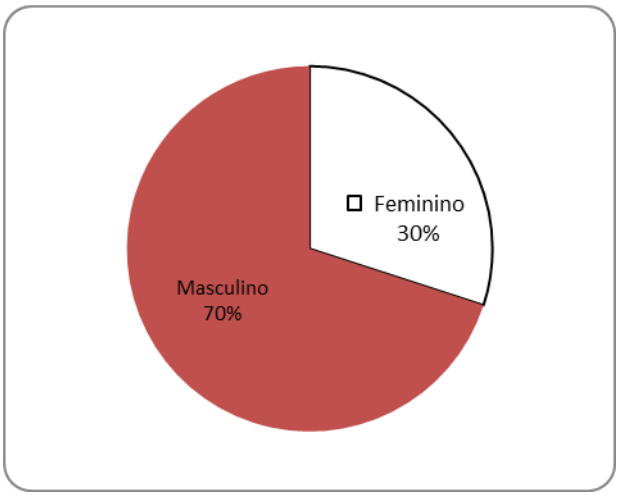


Figure 1: Users of the channel by gender.
Source: www.youtube.com/v13dinei

Data from the Higher Education Census from 2011[8] show that women are the majority of people enrolled in the Brazilian traditional higher education courses (55.1 %) and they are the majority of those who actually graduate (58.8 %). In e-learning, the difference is more stressed, going to 69.2% of enrollments and 76.2 % of graduates.

[8] www.portal.mec.gov.br

The average age of Brazilian university students from traditional face-to-face education is 21 years old; the most frequent age for conclusion is 23 years old; and the average age for conclusion is 28 years old. In relation to e-learning, the average admission age is 28 years old, while 36 years old is the average age for conclusion.

Also according to the Higher Education Census from 2011, 18% of students are in the age range from 18 to 24 years old, 19% are in the age range from 25 to 30 years old, 17% from 31 to 35 years old, and 11% are 36 years old or over.

These ratios are close to the ones indicated in Table 02, which means that the profile of the users from channel v13dinei is close to the profile of the Brazilian university student, except that, in our channel, 70% of the users are males, against 30% of females, opposing the fact that, in the Brazilian higher education, most students are women.

Such fact may be justified by the survey conducted in the study by Smeding (2012), who uses reports from the European Commission from 2006, and from the National Science Foundation from 2009, and observes that the number of women enrolled in courses from the areas of Science, Technology, Engineering, and Mathematics is lower than the number of men in those courses.

Another reason for the difference between the number of accesses made by men and women is that the majority of Brazilian Internet users are males (54%), according to a survey conducted by the Brazilian Association of Educational Technology (ABT)[9].

Table 02 shows that most users of the channel from the ten countries with more accesses recorded are in the age range from 13 to 54 years old. Such age range concerns: High School students, university students and adults that returned to the teaching system to complete their studies or to prepare for public service exams.

Table 02: Views per age range in the 10 countries with the most number of views.

Country	Views	13-54 years old	55 + years old
Brazil	1848238	88.5%	11.5%
Mexico	92984	94.3%	5.8%
Portugal	90262	90.2%	9.7%
Colombia	76416	94.6%	5.4%
Peru	29539	92.6%	7.3%
Chile	28948	94.4%	5.7%
Venezuela	28290	86.2%	13.7%
Spain	27013	89.2%	10.7%
Germany	24721	90.2%	9.9%
Argentina	24391	91.4%	8.5%

Source: www.youtube.com/v13dinei

Such data reinforce our hypothesis that, regardless of the educational level to which the users of the channel belong, they watch the videos from the channel to support their regular studies.

In the next section, we will categorize the comments made in the channel to better understand the reasons that make users watch the videos available and to know a little about their profile.

[9] http://www.abt-br.org.br/index.php?option=com_content&task=view&id=313&Itemid=2

4.4 A study on the comments made in the channel

In the search to understand what users look for in our channel, we selected comments that would give us hints on their relationship with the material available. For such, we classified the comments into seven categories (Chart 02).

Chart 02: Categorization of the comments from the users of channel v13dinei

Category		Examples of comments from the users[10]
01	Tips on aesthetic procedures to improve the videos.	Your explanation is very good, however, when the explanation begins, a part of the screen shifts to the teacher, which makes the left part of the resolution of the equation impossible to see (Zico).
02	Interest from other users in producing similar videos.	I would like to know what software you used in the videos to write as if it were "by hand" (Antônio).
03	Request for help to solve exercises suggested by teachers from regular teaching institutions.	Hello, teacher, thank you for your quick answer. I'm from Colombia and I have been watching one of your videos http://www.youtube.com/watch?v=2Zjy7yTqQLI. I understand this exercise well, but the professor from my university recommended us to study the method without a formula; could you help me with a video to answer the exercise that was previously sent or help me with any material on second order implicit derivatives, or even trigonometry would be much better. Thank you, have a nice Sunday. (Mercedez).
04	Tips on procedures that make videos useful for studies.	• Thank you for the initiative and for posting such **didactic** videos!!! It will really help everyone (and I'm included) with their studies. Best regards (Odair) • Great explanation. I loved it!!! **Step by step** is much better, congratulations. (Juanita). • No offense, but that is it? Why does my teacher make it so much **harder**? :/ (Marlon).
05	Doubts resulting from the videos.	Could you give me examples on 3x3, 4x4, 5x5 square matrices? And how do I know whether a matrix is diagonalizable? I know that in order to get to that we need to go through some other steps before, but I just need to understand this better for my exam. Thank you in advance. (Gabriela).
06	Corrections made by	Wouldn't 2P in the equation equal -8? After all,

[10] Fictional names.

	users.	the parabola has a downward concavity (Carlos).
07	Comments that relate the videos with regular face-to-face exams.	Your videos have saved me before the exams! Keep on with the great work (Luana).

Source: www.youtube.com/v13dinei

The importance of Categories 01 and 04 lies in the fact that the users show to the producers of the channel aesthetic possibilities and tips to facilitate the studies through the videos, which contributes so that future videos would meet the needs of the users.

Note that the categories 01 and 04, bring up some of the proposed principles by Mayer (2000), for example, the first show that the student Zico valorizes the recommended characteristics by the principles of spatial contiguity (P04) and temporal (P05), which reinforces the importance of the digital videos trying to contemplate the principles for a strange processing reduction.

The categories 03, 05 and 07, reinforce what Bransford et al. (2000) defend the importance of beginners in certain study fields, to have contact with the way of thinking of specialists. In our case, this type of contact happened between digital recorded videos by a teacher of AL, and that assisted beginner students in this study field to understand how discussion happens in this scenario.

Category 02 shows that there are many other teachers interested in producing digital material for their students, what can be a good indicator from the educational point of view, and suggest that students and teachers, who are more immersed in the digital universe, extend the limits of a classroom to an enlarged horizon, such as Youtube, where the teachers can talk about mathematical concepts not just with their students, but also with other people from different regions and countries. This can open up discussions and give opportunities for students to see the concepts studied from other points of view.

Note that the categories 01 and 04 bring up some of the proposed principles by Mayer (2000). For example, the first category shows that the student Zico valorizes the recommended characteristics by the principles of spatial contiguity (P04) and temporal contiguity (P05); this reinforces the importance of the digital videos trying to contemplate the principles for a strange processing reduction.

The categories 03, 05 and 07, reinforce what Bransford et al. (2000) defend the importance of beginners in certain study fields, to have contact with the way of thinking of specialists; in our case, this type of contact happened between digital recorded videos by a teacher of AL and that assisted beginner students in this study field to understand how discussion happens in this scenario.

Category 02 shows an example of a user who accesses the channel to search for ideas, exchange experiences and produce his/her own videos. Categories 03 and 07 show that students from regular schools use the channel to complement the activities from their respective courses. This fact reinforces our hypothesis that the videos may help students with their extra-class studies

For Jung *et al.* (2012, p. 907),

> the interactive and flexible nature of the internet enables individuals to be more active users. Compared to the use of other media, individuals can now engage in diverse types of activities on the internet and construct different meanings of the internet in their everyday lives.

Considering the comments from Category 05, we notice that several users are not restricted only to watching the videos. They relate what was shown in the video with what they are studying, which shows that such media have the power to promote the interaction between the topics shown and that what the students know about the subject.

5. Final considerations

The analysis of the data supplied by YouTube Analytics showed that the users from the v13dinei channel are mostly males (70%) within the age range from 18 to 54 years old, living in Brazil, High School students or in the initial periods of Higher Education, or even individuals who are preparing for public service exams.
Among the reasons listed for such profile, we mention the fact that, in general, there is a higher number of males enrolled in courses from the areas of Science, Technology, Engineering, and Mathematics, although the number of females in those courses has been increasing over the last decade (Smeding, 2012).

The age range of the visitors that access the channel the most is similar to the age profile of e-learning students in Brazil or High School students. Thisindicates that the fact that the students are used to the digital media makes it easier for them to study with digital videos as backup for their didactic activities from their graduation courses.

Since all the videos in the channel are in Portuguese, it is expected for most accesses to be from countries with a language close to ours. An evidence of such fact is that, among the 10 countries with the largest number of views, the official language of two of them is Portuguese (Brazil and Portugal) and seven are Spanish-speaking countries. The only exception is Germany, which is in the ninth position in number of views. A possible explanation would be that German users that access our channel are immigrants from Portuguese or Spanish speaking countries.

Another important consideration is that the most browsed subject by the users of the channel is Linear Algebra (LA); this may indicate that such videos meet the expectations of the students or somehow collaborate to solve their doubts.

For Giannakos & Vlamos (2010, p.67), digital videos with good graphical quality, easy language and detailed explanation may attract the attention of students who have difficulties to concentrate during traditional face-to-face classes. Traditional classes usually show a series of distractions that the interaction with the computer may provide for. That is why "the vital ingredients for creating video classes are delimiting the theme discussed and the pedagogic and aesthetic characteristics of the video".

The characteristics of the videos made available in our channel are described throughout the study by Guiannakos & Vlamos (2010, p.66), namely: they do not exceed 20 minutes, the argumentation of the teacher and tone of voice try to maintain the attention of the students, making them think about what they are watching, and the videos are structured in three parts. The total time of the videos is divided as follows: introduction from 10 to 20 % of the time, development from 65 % to 80 %, and conclusion, from 10 % to 15 %.

We know that there are several educational videos from questionable sources which may induce students to conceptual mistakes. Thus the importance of teachers producing their own materials and posting them to their students. Such behavior may help students during their individual studies, in addition to helping teachers in class, since, if students come to face-to-face or online classes having

already studied the content, the class will be the moment to go deeper into the content, to discuss and share experiences.

Not all students have the financial conditions to buy good books, and not all universities have books available to lend at all times for all the students who need them. Such a thing does not occur with free digital videos, which are available 24 hours a day, seven days a week for reference.

Another characteristic of digital videos is that remarks may be easily added about, for example, typo and calculation mistakes. This does not occur with printed books, which demand a large investment and time to be revised and edited.

The analysis ofusers' commentsfound in our channel indicates that those who refer to the materials available suggest questions that go beyond what the video shows; relate the videos with the contents from their exams or regular classes; and point tips to make such media more attractive.

We think the relevance of this research is not in its statistical nature, but in giving some indications as to where students go to find subsides to study Mathematics, drawing attention to the importance of this theme as a source for research in Mathematical Education.

The production of digital videos can be an opportunity of teachers to know new technological tools and in this way to develop strategies to use their educational potential. That is fundamental when the computerization is closer to Brazilian schools, demanding from the teachers new strategies that can be offered as free tools, such as Youtube, to motivate students, who will respect the contents taught.

Even though this study is focused on only one channel,with limited contents and restricted to a certain level of study, the analysis enables us to highlight that videos do not transfer knowledge to students, and the process of learning AL is complex and difficult to be depleted. However, we believe that the contact with such media can enrich the discussions in the classroom, favoring the concept of AL.

6. Acknowledge

We thank the PECIMAT group for useful discussion and Espaço-Escrita/Unicamp for the English version of this paper. V.C.C. acknowledges the CAPES doctoral scholarship and SRO acknowledges the MEC-FNDE/Condigitais grant.

7. References

Arcavi, A. (2006). El desarrollo y el uso del sentido de los símbolos. In: VALE, T.; PIMENTEL, A.; BARBOSA, L.; BARBOSA, L.; FONSECA, L.; SANTOS e CANAVARRO, P.. (Eds.). *Números e Álgebra na aprendizagem da matemática e na formação de professores,* (pp. 29-47). Caminha: SEM-SPCE.

Bergmann, J. & Sams, A. (2010). *Flip your Classroom: reach every student in every class every day.* Washington: International Society for Technology in Education.
Bransford, J. D. *et al.*(2000). *How people learn: brain, mind, experience, and school*. Washington: National academy press.

Celestino, M. R. (2000). *Ensino e aprendizagem de álgebra linear: as pesquisas brasileiras na década de 90.* Dissertação (mestrado). Pontifícia Universidade Católica de São Paulo. São Paulo.

Disponível em: http://www.pucsp.br/pos/edmat/ma/dissertacao/marcos_roberto_celestino.pdf. Acesso em 16 abr. 2013.

Clark, R. C.; Nguyen, F. & Sweller, J. (2006). *Efficiency in learning: Evidence-based guidelines to manage cognitive load*. San Francisco: Pfeiffer.

Giannakos, M. N. & Vlamos, P. (2010). *Comparing a well designed webcast with traditional learning.* SIGITE 10 Proceedings of the 2010 ACM conference on Information technology education, New York, p. 65-68. Acesso em 30 mai., 2013, http://dl.acm.org/citation.cfm?id=1867669.

Giannakos, M. N. & Vlamos, P. (2013). Educational webcasts' acceptance: Empirical examination and the role of experience. *British Journal of Educational Technology*. Acesso em 01 jun., 2013, http://onlinelibrary.wiley.com/doi/10.1111/j.1467-8535.2011.01279.x/full.

Jung, J.-Y.; Lin, W.-Y. & Kim, Y.-C. (2012). The dynamic relationship between East Asian adolescents´use of the internet and their use of other media. *New Media & Society.* Acesso em 15 mai. 2013.
http://intl-nms.sagepub.com/content/early/2012/03/14/1461444812437516?patientinform-links=yes&legid=spnms;1461444812437516v1.

Mayer, R. E. & Durso, F. T. (1999). *Instructional technology. Handbook of applied cognition.* New York, NY, US: John Wiley & Sons Ltd.

Mayer, R. E. (2003). Elements of a science of E-learning. *J. Educational Computing Research.* New York: Baywood Publishing Co., Inc.. Acesso em 10 mai. 2013. http://cecs5580.pbworks.com/f/elements%2Bof%2Ba%2Bscience%2Bof%2Be-learning.pdf.

Mayer, R. E. (2009). *Multimedia Learning.* New York: Cambridge University Press.

Meira, L. (1994). *Análise microgenética e videografia: ferramentas de pesquisa em psicologia cognitiva.* Recife: editora UFPE.

Santaella, L. (2006). *A Teoria Geral dos Signos.* São Paulo: Pioneira Thomson.

Schineider, K. G. (2001). Lights! Cameras! Action!. *American Libraries*. Acesso em 20 abr. 2013, http://www.americanlibrariesmagazine.org/inetlibrarian/2001columns/august2001lights.

Smeding, A. (2012). Women in Science, Technology, Engineering, and Mathematics (STEM): An Investigation of Their Implicit Gender Stereotypes and Stereotypes' Connectedness to Math Performance. Sex Roles. Acesso em 10 jun. 2013, http://link.springer.com/article/10.1007%2Fs11199-012-0209-4.

Sweller, J. (2005). Implications of cognitive load theory for multimedia learning. In R. E. Mayer (Ed.).The Cambridge handbook of multimedia learning (pp. 19–30). New York: Cambridge University Press.

Virvou, M.; Katsionis, G. & Manos, K. (2005). Combining software games with education: evaluation of its educational effectiveness. *Educational Technology & Society.* Acesso em 10 mai. 2013, http://ifets.info/journals/8_2/ets_8_2.pdf#page=59.

Virvou, M. & Katsionis, G. (2008). On the usability and likeability of virtual reality games for education: The case of VR-ENGAGE, *Computers and Education.* Acesso em 20 mar. 2013, http://www.unipi.gr/faculty/mvirvou/ComputersEducation_VirvouKatsionis_Revised.pdf.

Yunus, A. S.; Kasa, Z. & Asmuni, A. (2006). Use of webcasting technology in teaching higher education. *International Education Journal.* Acesso em 20 mar. 2013, http://ojs-prod.library.usyd.edu.au/index.php/IEJ/article/viewFile/6791/7433#page=50.

Zhou, G. & Xu, J. (2007). Adoption of educational technology ten years after setting strategic goals: a Canadian university case. *Australasian Journal of Educational Technology*. Acesso em 13 mai. 2013, http://www.ascilite.org.au/ajet/ajet23/zhou.html.