

IS MATHS EVERYWHERE? OUR STUDENTS RESPOND

J. Mulero¹, L. Segura², J.M. Sepulcre²

¹*Department of Statistics and Operation Research, University of Alicante (SPAIN)*

²*Department of Mathematical Analysis, University of Alicante (SPAIN)*

julio.mulero@ua.es, lorena.segura@ua.es, jm.sepulcre@ua.es

Abstract

Mathematics expresses itself everywhere, in almost every facet of life - in nature all around us, and in the technologies in our hands. Mathematics is the language of science and engineering - describing our understanding of all that we observe. In fact, Galileo said that Mathematics is the language with which God has written the universe.

Aristotle defined mathematics as "the science of quantity", i.e., "the science of the things that can be counted". Now you can think that counting has a vital role in our daily life; just imagine that there were no mathematics at all, how would it be possible for us to count days, months and years? Unfortunately, people usually ignore the connection between mathematics and the daily life.

Most of university degrees require mathematics. Students who choose not to take seriously mathematics or to ignore it in high school, find several difficulties when they come up against them at the university.

This study explores the perceptions of how mathematics influences our daily life among our students and how teachers can use this information in order to improve the academic performance. The used research instrument was a questionnaire that was designed to identify their understanding on learning mathematics.

Keywords: Dissemination, mathematics.

1 INTRODUCTION

Traditionally, mathematics has been viewed as separated from daily life. In general, the viewing of an work of art, the watching of a movie or a TV series or the reading of a book do not lead to the observation of the mathematical concepts that sometimes inspire or support them.

As Stephen Wilson claimed in [1] "the role of the artist is not only to interpret and spread scientific knowledge, but to be an active partner in determining the direction of research". In spite of reductive opinions that pretend an artificial separation of Art and Science as independent domains of Culture, their mutual and profound relation is instead due to the fact that Art and Science had always gained reciprocal impetus since the Antiquity, so that in the age of "New Science" a separation of Art from the impressive development of scientific knowledge is in fact impossible and sterile.

From our last papers [2,3] where we showed the raising of a course in order to instill in students that learning in a fun way can be used to extract the essence of the different mathematical activities, we think about the goal of analyzing the perception of the university students on the connection between mathematics and the daily life.

In the daily development of classes, the lecturer detects that the use of these connections that make light the abstract nature of mathematics is very motivating for students. Thus, it is suitable to enhance the showing of mathematical content through nearby and everyday examples.

2 PURPOSE

The main objective of this study is to explore the perceptions of how mathematics influences our daily life among our students and how teachers can use this information in order to improve the academic performance. As a consequence of it, our particular objectives are the following:

- To know the sensations among the students about mathematics.

- To find out concrete and mathematical examples which these students know related to architecture, art, cinema, television and literature.
- To pick up students' thoughts about the academic mathematics that they learned.
- To identify the students' opinion about creativity and mathematics.

3 METHODOLOGY

Basically, the research instruments used in gathering data, in order to identify pupils' knowledge and understanding on mathematics mentioned above, were two questionnaires designed by the authors of this paper. These questionnaires were distributed to 94 students of the first course of the degree in Biology and in Marine Studies of the Sciences Faculty of the University of Alicante.

3.1 Likert-type questionnaire

A Likert scale is a psychometric scale commonly involved in research that employs questionnaires. It is the most widely used approach to scaling responses in survey research. When responding to a Likert questionnaire item, respondents specify their level of agreement or disagreement on a symmetric agree-disagree scale for a series of statements. Thus, the range captures the intensity of their feelings for a given item [4].

In our case, the Likert-type questionnaire which was designed is based on 19 items. Our students just had to answer each question on a scale from 0 to 5 (0 meaning totally disagree and 5 meaning totally agree). The questions that form part of such questionnaire are the followings:

1	<i>Do you agree with the separation of science and arts that society has established in advance?</i>	2	<i>In general, are you satisfied with the mathematical knowledge that you have learnt during your studies?</i>
3	<i>Do you consider that mathematics plays an important role in society?</i>	4	<i>Do you consider pertinently the exposed relationship between this mathematical knowledge and culture in general?</i>
5	<i>Do you consider that mathematics only entails memorizing and a following of concrete rules?</i>	6	<i>Do you think that mathematics is uniquely characterized by the capacity of making use of rules and calculating quickly?</i>
7	<i>Do you think that mathematicians work of an isolated form and apart from society where they live?</i>	8	<i>Do you think that mathematics requires of a certain creative skill?</i>
9	<i>Do you think that mathematics is beautiful?</i>	10	<i>In general, do you consider that mathematics is included in art?</i>
11	<i>According to your general impression, do you think that the presence of mathematics in the works of art discredits the artistic interest of them?</i>	12	<i>Do you know many films whose main character is a mathematician?</i>
13	<i>Do you think that cinema or television insist on the freak facet of Scientifics?</i>	14	<i>In general, is the mathematical overloading of a movie script counterproductive for the audience?</i>
15	<i>Would the mathematical advising be profitable in making a movie script?</i>	16	<i>Dou you think that geometry takes significantly part in the design of a work of art?</i>
17	<i>Would you be capable of recognizing some mathematical concept in a sculptural, pictorial or architectural work?</i>	18	<i>How strongly do you agree with that the fact that mathematics takes part in the drawing and execution of an architectural work?</i>
19	<i>Do you know some architect who shines in one's own right for their mathematical contribution to architecture?</i>		

The obtained results can be summarized by figure 1.

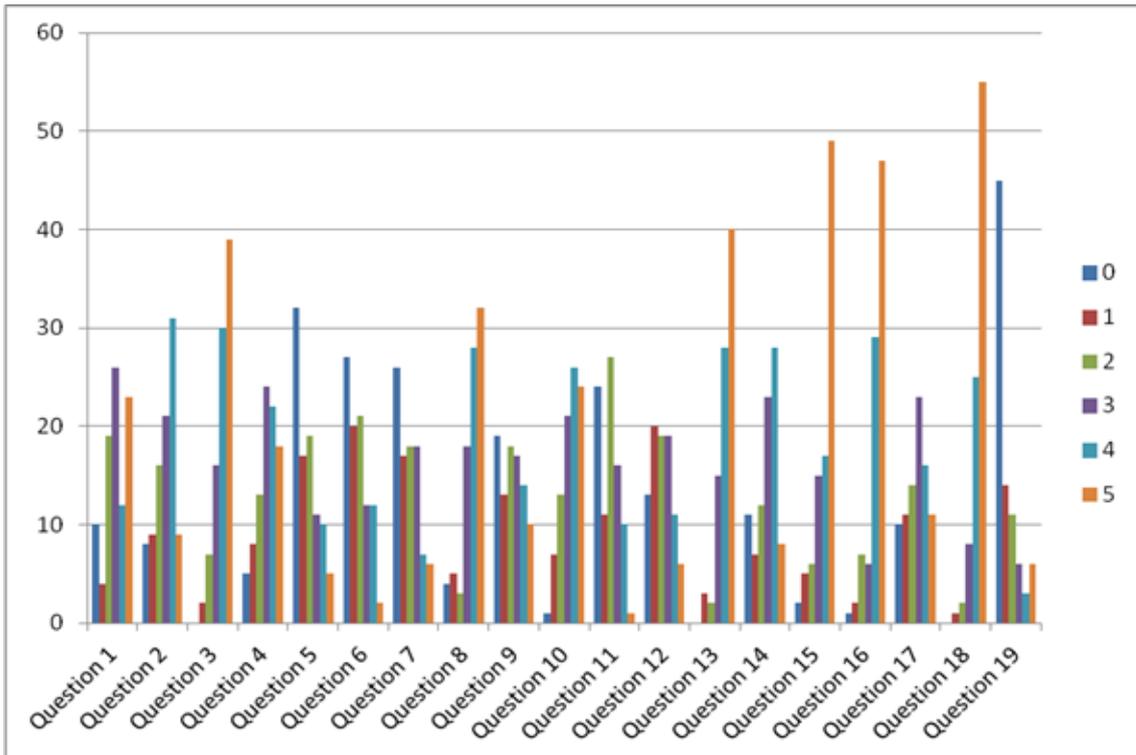
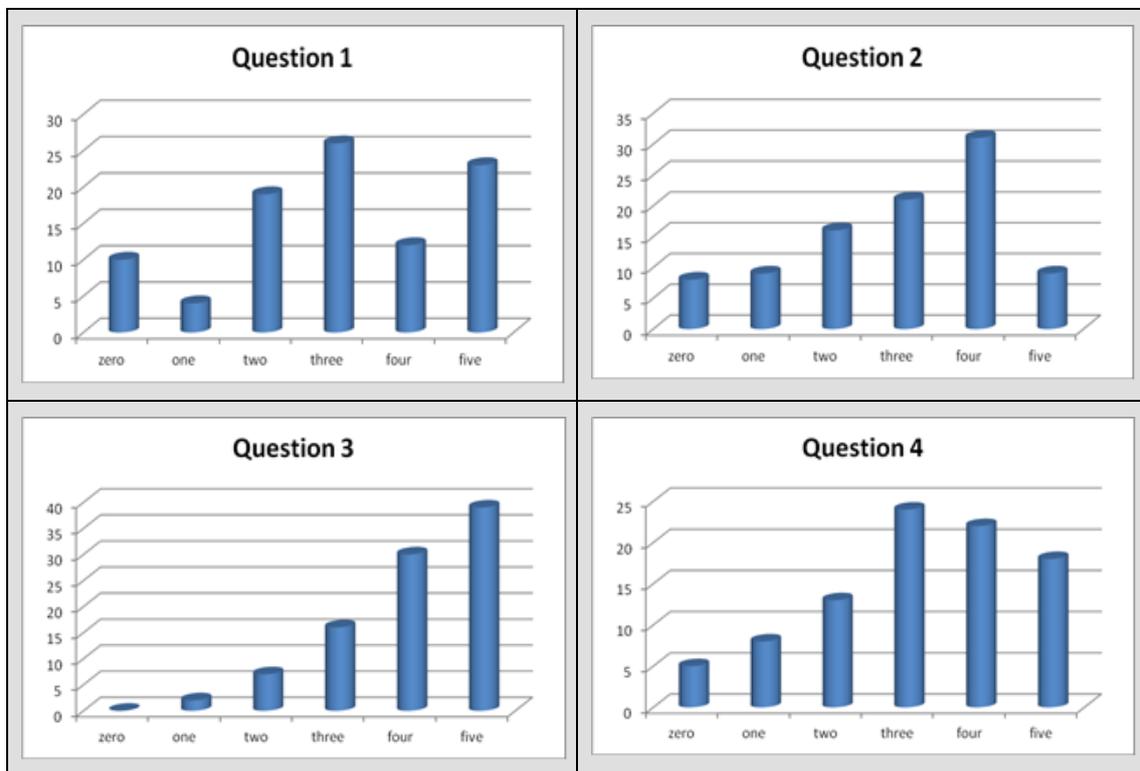
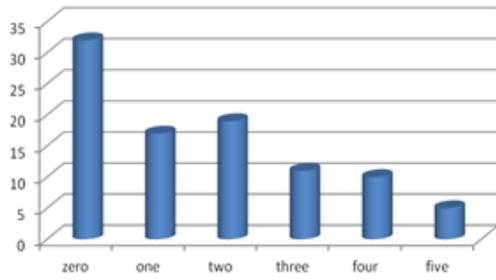


Figure 1. General results

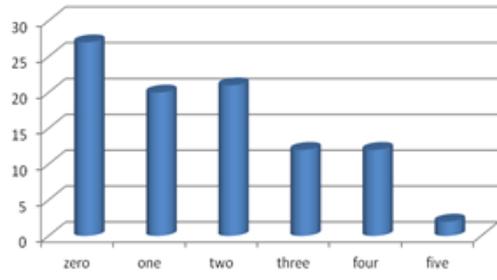
We also show the particularized results in figure 2. There, we properly observe the students' opinion in each one of the questions that takes part in the questionnaire.



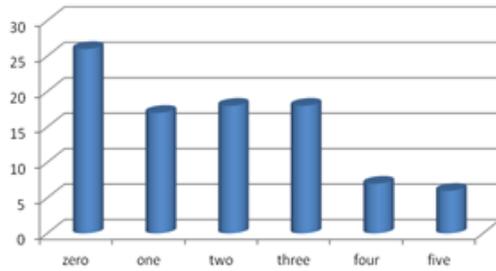
Question 5



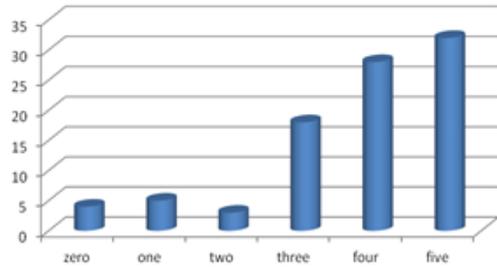
Question 6



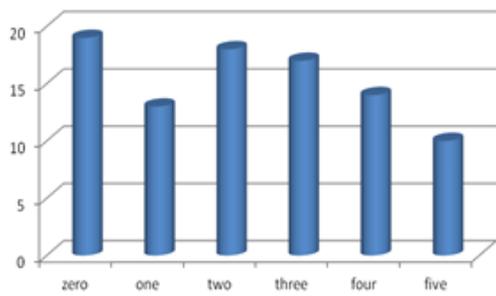
Question 7



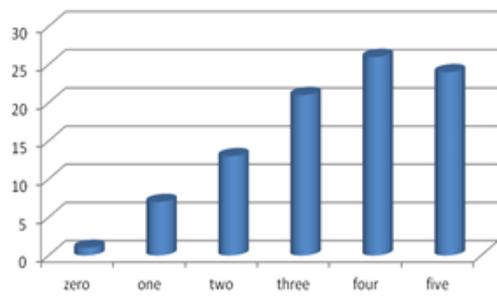
Question 8



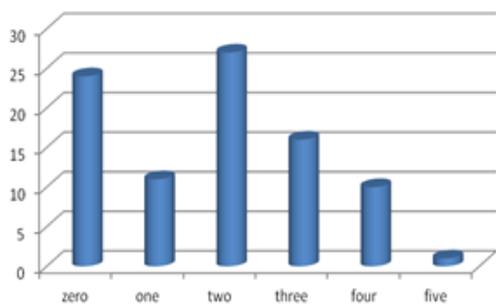
Question 9



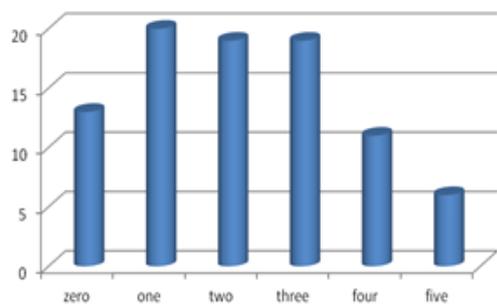
Question 10



Question 11



Question 12



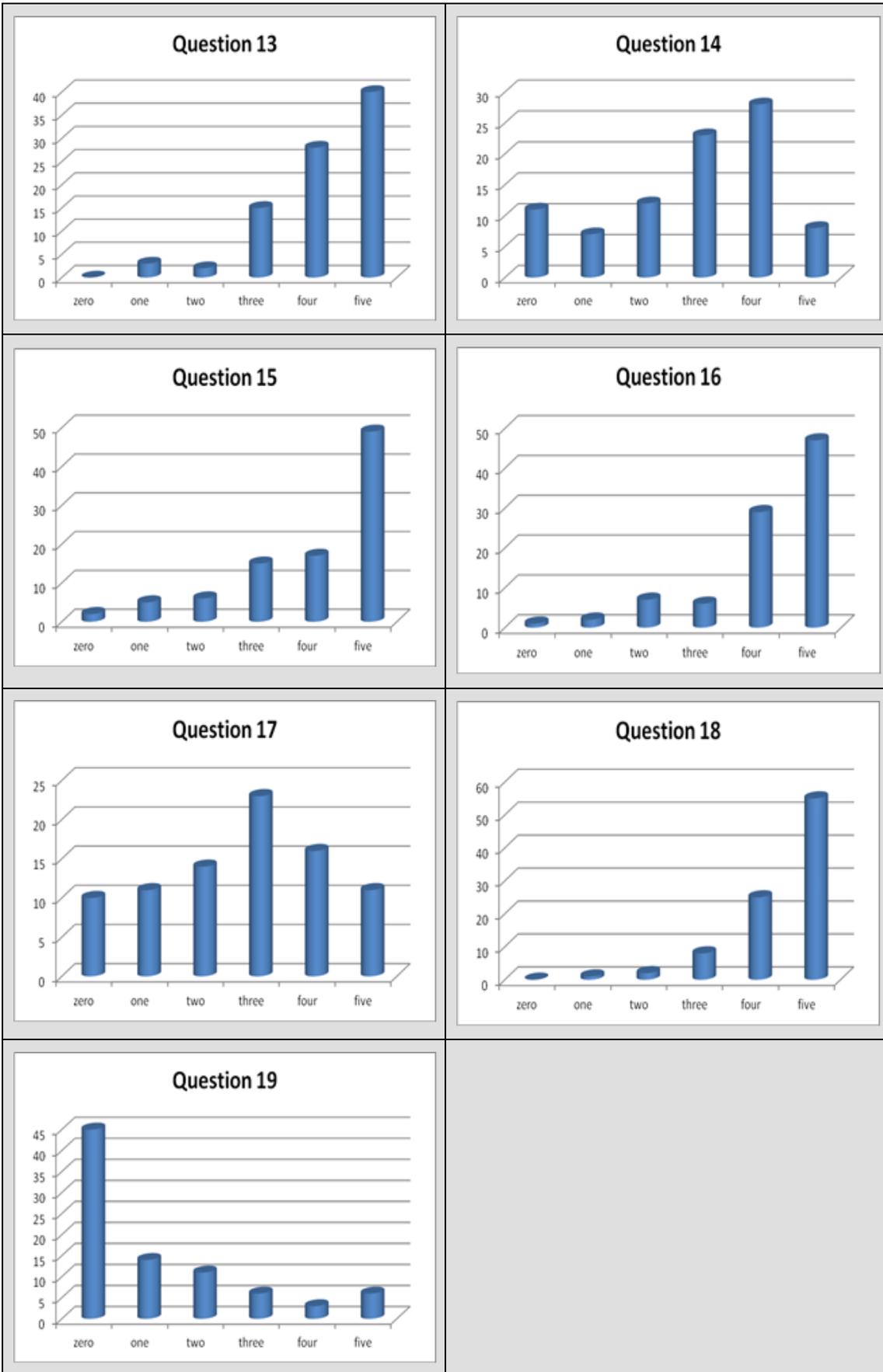


Figure 2. Particularized questions

Consequently, we can clearly extract several conclusions.

- Students' opinion is that mathematics plays an important role in society (question 3). In fact, 70 students from a total of 94 assessed that question by 4 or 5.
- Most of the surveyed students (64 respondents with 3, 4 or 5) consider timely the demonstration of the relationship between mathematical knowledge and culture in general (question 4). It is also true that some of them expressed the point of view that this relationship should be more documented.
- Students believe that mathematics does not uniquely involve memorization and rule-following (question 5). In fact, a total of 67 students responded with 0, 1 or 2. That is, they express the point of view that it is necessary to understand many aspects of mathematics to subsequently apply them, that there is a reasoning factor and that it is something deeper than mnemonics rules or memory.
- It is also clear that respondents believe that mathematics requires some creative ability (question 8) and it is not only characterized by the ability to apply rules and calculate quickly (question 6). Almost a total of 80 and 70 people respond respectively in that direction.
- Most (70 student respond with 3, 4 or 5) considers that maths is present in art (question 10). In fact, some of them say that mathematics is present in all aspects of life.
- It is also emphatic the opinion about that the film or television insists on the freak facet of scientists (question 13). A total of 83 respondents answered with 3, 4 or 5. Many of them state that mathematicians appear on the big screen uniquely in a freak facet, but they think that, in reality, the mathematicians are the only characters that solve everything. Many films show effectively the topic of mad scientist who dreams of the world domination.
- According to respondents, the professional advice of mathematics would be helpful in a movie or series of some mathematical content (question 15). Over 80 respondents answer strongly in this direction. In this sense, they see it necessary in the case of that the managers want to draw attention to a particular audience.
- It is also striking that geometry involved heavily in the design of any artistic work (question 16). Nearly 80 people respond with 4 or 5 to this evidence.
- 80 respondents also respond with a 4 or 5 (i.e. largely) to the question: How strongly do you agree with that the fact that mathematics takes part in the drawing and execution of an architectural work? (question 18).
- Approximately 55% of respondents did not know any architect who is leading the mathematical contribution to architecture (question 19). Instead, many of them recognize that, although they do not know anybody, it is sure that there must be. Others give examples as Gaudí or Santiago Calatrava.

The remaining questions present more varied replies as we can see in Figure 2. For example, we note the following:

-Some of the students claim that it should be a separation, but not radical, between science and arts in society.

-The mathematical knowledge that is acquired, in large part, is directly influenced by the teacher's ability to transmit it.

-Many of them think that not all mathematicians work of an isolated form and apart from the society in which they live.

-On the question of whether mathematics is beautiful, some of them say that it is so uniquely if you understand it or if you know how to apply it correctly. Others think that mathematics is something that is abstract and that everything is based on it.

-A large percentage of respondents do not know many movies whose main character is a mathematician. Of those who do know some movies (or series), they give the following titles: Numbers, The Oxford Murders, Fermat's room, A beautiful mind, Agora or Big Bang Theory.

-There is a great variety of answers regarding whether it is counterproductive for the audience to overload of mathematical content a script. Some of them think that it could be prejudicial and others think that it is not counterproductive in the case that the approach is good. Indeed, the

series Numb3rs is overloaded of a mathematical content and it does not seem to be counterproductive to many of the viewers.

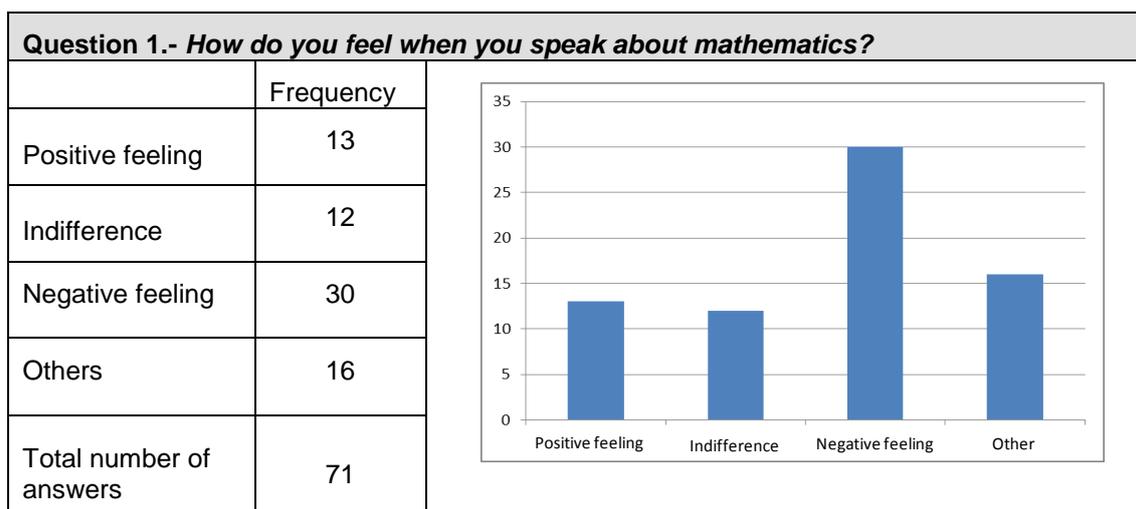
-Many of them would not able to recognize, at this moment, a mathematical concept in a sculpture, painting or architecture. In contrast, other cited the example of the churches' domes.

In the original packaging of the survey, it was also included the question "Do you think that mathematics is created or discovered?". We have not included it in the results because many respondents doubted on how to respond to it numerically. Anyway, following some of its comments, most of the students believe that mathematics is discovered because it is part of nature. A high percentage also believes that it is, in part, created and it is also in part discovered because if there is no creation, then the discovery cannot be. Finally, others also commented that mathematics is discovered provided you have the skill, imagination and interest in discovering something new.

3.2 Open-ended questionnaire

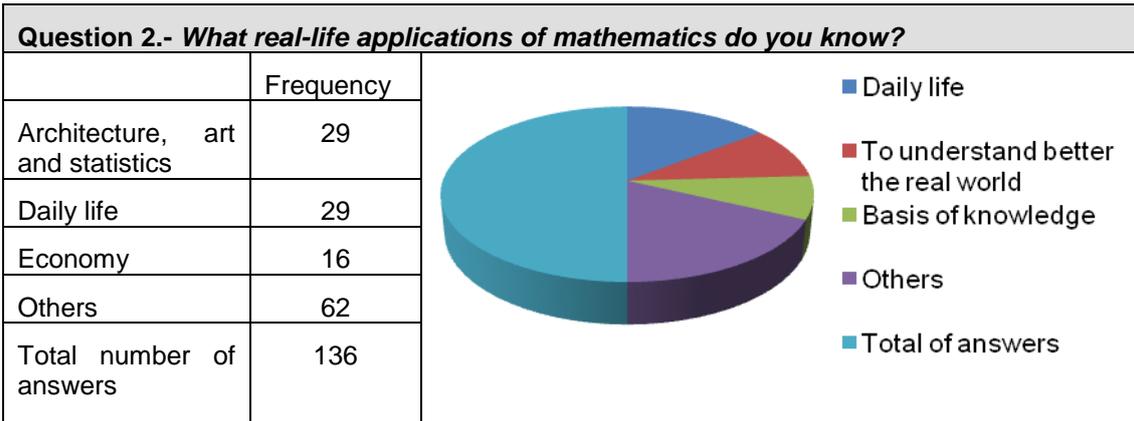
In order to try to understand the concept that our students have around our subject, we started by proposing a survey course where they can freely respond.

The responses were analyzed and grouped. Obviously, the open nature of the questions determines the answers. So, in each one of them we find a great diversity which makes difficult a detailed study. However, a study of their responses broadly enables a better understanding of the overall vision. Here are the answers, roughly, that students give to six questions.



The feelings that students experience when talking about math vary from indifference to oppression, with frustration and also boredom.

As it is shown in the graph, the students' point of view is negative since most refer insecurity, stress, overwhelmed or even afraid. Among the mentioned positive feelings, we find the curiosity and that it is a basic matter which provides them comfort and culture. However, there are also students who are indifferent to talk about mathematics which consider it a subject such as any other.

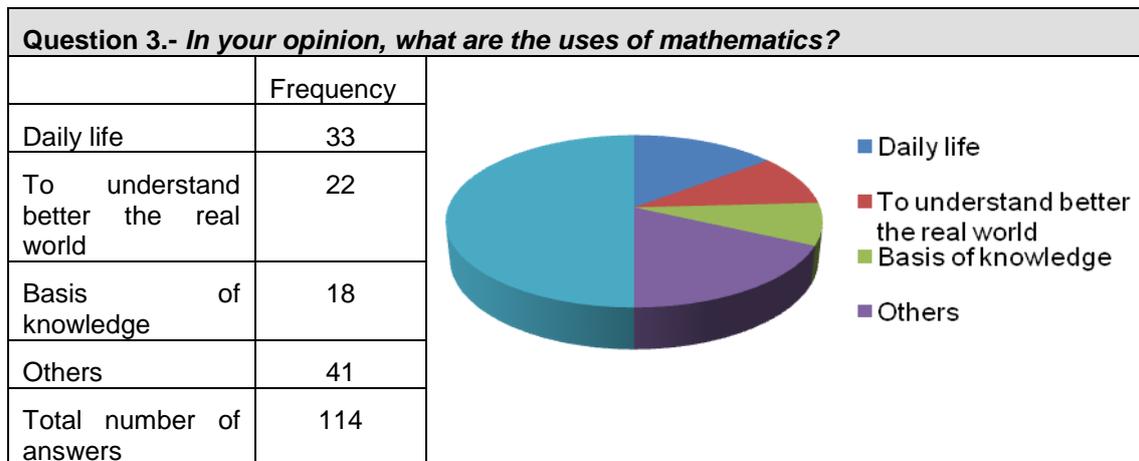


As it can be observed, the majority of the students link mathematics with art and daily life problems and many of them imagine its applications to the economy scope. However, there are a lot of different answers such as new technologies or simulations. Only 7 students answer that there is no application to the real life.

Among the more interesting answers, we find the following:

“Mathematics is present in the whole real-life, I cannot think anything where there is no mathematics”.

“Sincerely very few applications, I do not think that there are a lot of them”.



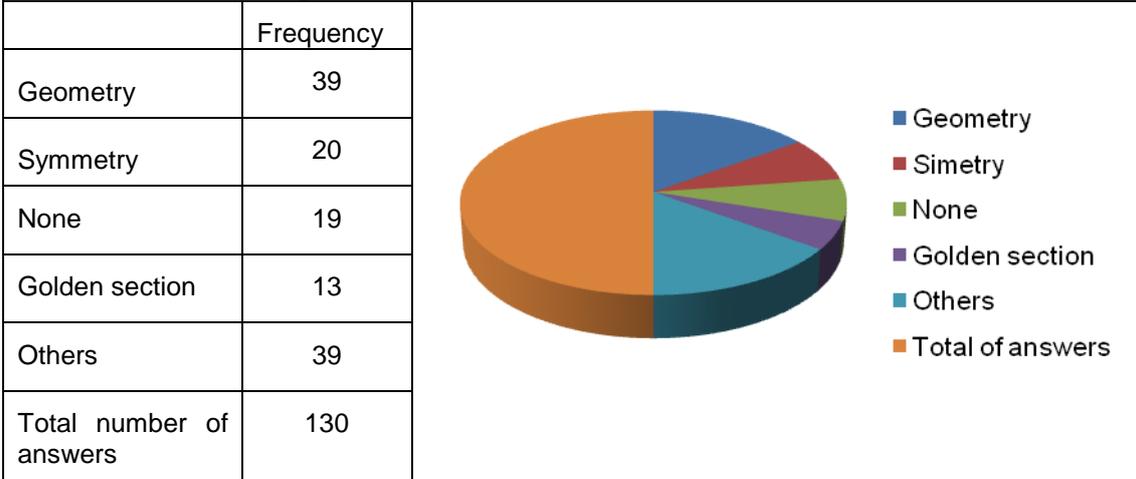
Students recognize the utility of mathematics to daily life and to understanding the world, as well as the universal and basic character of this subject. However, we find specially interesting that five of them affirm that mathematics help them to open and speed up their mind in order to solve problems.

Some of the most interesting answers were:

“Mathematics is used to organize and order the world. We need mathematics to explain and understand it.”

“Mathematics creates rules that permit to understand the universe.”

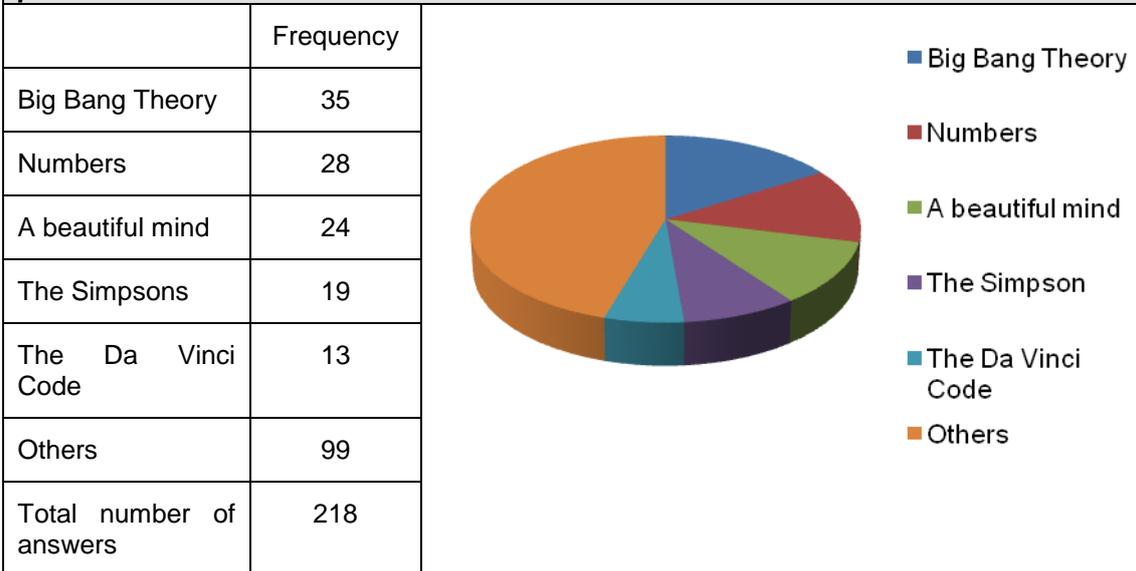
Question 4- List almost two mathematical aspects that you observed in works of art or architectural masterpieces.



In this answer, we are surprised with the high quantity (in particular, 19) of students that think that there are no mathematical aspects in the works of art and architectural masterpieces.

Most of the answers are related to the necessary calculus in the execution and development of the works, but a few of them relate it with its design.

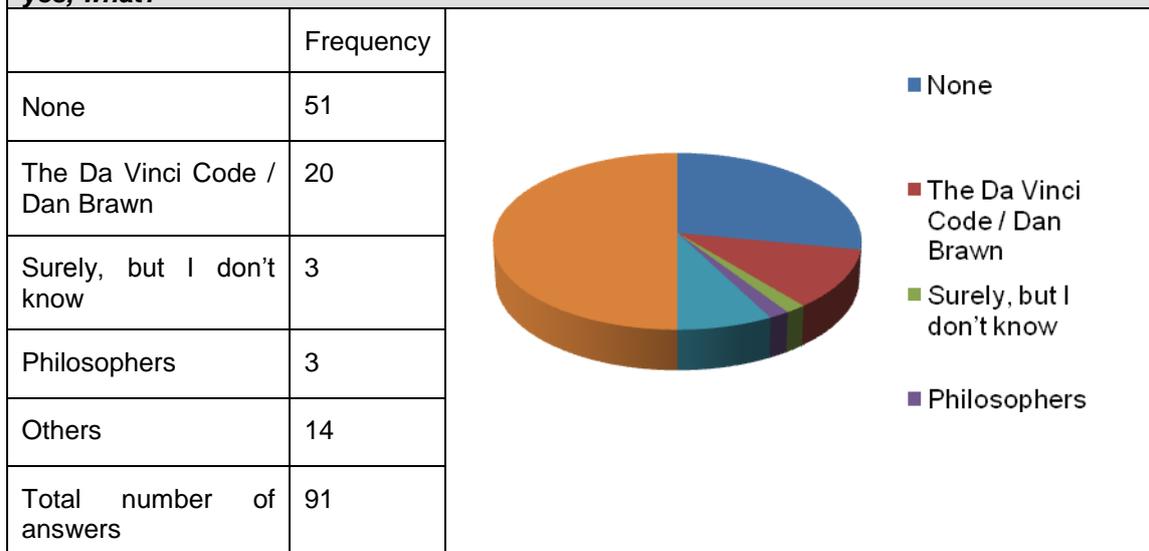
Question 5- What movies or television series do you know where mathematics are present?



In general, students know a lot of different movies or television series where mathematics is present. In particular, they mention more than 34 audiovisual works. Among the films, some of them are rarely known as “Cube” or “Pi”.

It is important to note that movies project an antisocial and paranoid image of mathematicians and this is pointed out by the students.

Question 6- Do you recognize any connection between mathematics and literature? If yes, what?



The data clearly show the lack of information about the relationship between mathematics and literature. This is an evidence of the social conviction of the distance between sciences and letters. However, contrary to what is widely believed by people, three of our students point out Socrates or Platon.

4 CONCLUSIONS

From this work, we can deduce that:

- Students consider that mathematics is a difficult subject and it develops negative feelings.
- Students are able to recognize mathematics in several real situations.
- Students appreciate this type of mathematical examples in order to illustrate and popularize mathematics.
- Students are aware of the relationships between mathematics and cinema or television and architecture and they mention a lot of examples and related concepts.
- Students think that the relationships between mathematics and literature are almost non-existent and furthermore they consider that there is a clear separation between sciences and letters.

REFERENCES

- [1] Wilson, S. (2010). *Art + Science Now*, Thames & Hudson. London, ISBN: 978-0500238684.
- [2] Mulero, J.; Segura, L.; Sepulcre, J.M. (2012). A new approach to disseminate mathematics. ICERI 2012 Proceedings, International Association of Technology Education and Development (IATED): pp: 4436-4442.
- [3] Mulero, J.; Segura, L.; Sepulcre, J.M. (2012). Un nuevo enfoque divulgativo para la enseñanza de las matemáticas en la docencia universitaria. X Jornadas de redes de investigación en docencia universitaria. La participación y el compromiso de la comunidad universitaria, University of Alicante: pp: 2035-2048.
- [4] Burns, Alvin; Burns, Ronald (2008). *Basic Marketing Research (Second ed.)*. New Jersey: Pearson Education. pp. 245. ISBN 978-0-13-205958-9.