Comparison Between The Method Of Venn Diagrams And A New Mnemonics To Determine The Validity Of Syllogisms

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Summary

The subject of logic and, in particular, the subject of Aristotelian logic is considered difficult to understand by students of humanities and, in particular, by those who follow the career of law. The objective of this work is to propose a new mnemonics that allows to learn the 15 valid Aristotelian syllogisms in a simpler way. To this end, under a qualitative approach, a list of questions was elaborated and an interview was applied to 10 students of the legal logic course of the Catholic University Sedes Sapientiae of Peru. As a result, it was obtained that, for the vast majority, the mnemonic method proposed in this article was more practical than the classical method of Venn diagrams proposed by nineteenth-century mathematicians. In conclusion, it can be said that teachers should offer their students, not only the method of Venn diagrams, but also the mnemonic method suggested in this work that is easier to assimilate.

Keywords: mnemonics, logic, Aristotelian logic, validity, categorical syllogisms, Venn diagrams.

Introduction

Logic is considered a demanding and somewhat complicated course especially if those who study this subject are training in the field of humanities because this type of students are reluctant to formal and mathematical knowledge. Therefore, all efforts that teachers devote to improve their pedagogical and didactic aspects should be welcomed because they help to understand in a simpler way complex aspects of this subject. In fact, the understanding of logic is fundamental for students, for example, to learn to deduce from a simple idea other ideas and, in that sense, this logic course is essential if you want to do a thesis. In this case, with respect to the subject of Aristotelian logic, a new mnemonics is proposed to learn by heart the 15 valid syllogisms in the light of first-degree quantificational logic and thus be able to retain in mind that list of four

symbols consisting of a number followed by three letters (which we know as the standard form of syllogisms) so that they can identify which are valid syllogisms and which are not. On this occasion we will seek to know if this mnemonics (which seeks to facilitate the retention of all valid syllogisms and which is based on ideas such as Barbara, Cesare and Festino) is simpler than the conventional method of Aristotelian logic based on Venn diagrams and which was designed by nineteenth-century mathematicians.

Background

Mnemonics has been used in earlier times such as the medieval era (Chaparro, 2008). Raimundo Lulio used mnemonics to be able to remember philosophical truths about reality and about divinity itself (Chaparro, 2018). However, even today it is used in courses such as physics (Berrío, 2019) and learning Basque (Goñi-Artola, 2019). Thus, it is no secret to anyone that there are many ways to memorize the column of noble gases of the periodic table of chemical elements. One of them is this: "The fool Arthur runs with Zeno to the corner" which actually alludes to each noble gas in this way: "**Hel Fool Arthur Krre with Xenon to the Rncon".**

According to Castro and Rémar: "Mnemonics is the procedure of mental association of ideas, schemes, systematic exercises, repetitions, etc. to facilitate the memory of something." (2018, p. 53). Indeed, mnemonics provides the possibility of reducing to a few letters, vowels, number, images or situations a large amount of information that we must learn in a short time.

Current psychological studies reveal the value of memory to understand complex or novel cognitive processes for the student who must take a test or must learn previous knowledge in order to understand knowledge difficult to assume (Montealegre, 2003). Likewise, there are studies that reveal the pedagogical and educational value of mnemonic learning (López et al. , 2013), which can be both the teacher's work and the student's own ingenuity. In addition, this value is not only revealed at the secondary level but also at the university level (Candia, 2016). According to Alvarez:

One of the characteristic features of modern philosophy and science was the contempt for everything that came from scholasticism. And that, of course, could not but include the boring mnemonics of logic and its lack of interest for empirical methods. (2014, pp. 30-31)

The above shows us that the use of mnemonics was very useful in ancient and medieval times and that, in addition, it was closely associated with the learning of logic. However, even in our time with so much technological development, it is necessary to take advantage of mnemonic techniques to learn more safely some knowledge that is difficult to assume spontaneously (Calvo 2022). For example, in some Intensive Care Units it has been argued that learning mnemonics has improved the standard of living of patients (Aceves, et al. , 2015). Specifically, the acronym "Quality" referred to "C for catheter, A for feeding and glycemia, L for skin and mucosal lesions, I head

tilt, D for pain/consciousness/delirium, A for airway and D for development of thrombosis" (Aceves, et al. , 2015, p. 222). This last case reveals that the use of memory techniques even helps to internalize the procedures that must be followed to provide quality care to patients.

Theoretical framework

This work is nourished by three disciplines: psychology, education and logic. From the point of view of psychology, memory is manifested by the ability to recall past experiences. According to Ballesteros: "Memory is a psychological process that serves to store encoded information" (1999, p. 705). The main function of memory is "(...) encoding, recording and retrieving large amounts of information that are fundamental for the adaptation of the individual to the environment" (1999, p. 706). Memory is involved with the learning processes of the human being. According to De Juan, De Juan and Enríquez (2011), memory in relation to learning fulfills the function of storing or retaining information and also serves to acquire skills whose basis is emotional or experiential. Human beings possess that ability and if we cultivate it properly we can perform better in different tasks.

From the point of view of education, it is possible to make memory more efficient through techniques and strategies aimed at improving the storage and retention of what has been learned. These techniques are known as mnemonics. For example, a mnemonic is applied when I decide to paint a nail to remind myself that tomorrow I must deliver an important package. According to Campos (1998), mnemonics can help memory by developing rules or mnemonic systems. Mnemonic rules serve to memorize contents and structures that want to be remembered in an established order.

There are many procedures to help memory remember and retain certain information. In the case of this work, we are interested in mnemonics based on an association. For example, if someone wants to remember the planets and their order, you can put together a phrase that makes you remember what you wanted. Thus the phrase "My Old Aunt of Mine Never Knew How to Use Numbers" can be used to, in that order, remember the planets of the solar system which are: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus and Neptune. (Etecé, September 24, 2022). Students looking to learn a lot of data could create their own mnemonics in order to be able to pass their practices and evaluations with high marks.

From the point of view of logic, we will resort to Aristotelian logic which considers as the main element the categorical proposition, the same that brings together quantifier, subject, verb and predicate, in that order. For example, such a proposition would be, "Some hyenas are wild." The four possible propositions, for Aristotle (1988), are SaP (All S is P), SeP (No S is P), SiP (Some S is P) and SoP (Some S is not P). The SaP indicates a total inclusion relation because the subject S is fully included in predicate P. This happens in "Every Lima is Peruvian". The SeP indicates a total exclusion relationship because the subject S is totally separated from the predicate P, as it happens

in "No adult is a neonate". SiP indicates a partial inclusion relationship because, in certain cases, the subject S and predicate P coincide in the same individual. Example: "Some apples are green." Finally, the SoP indicates a partial exclusion relation because, in certain cases, the subject S and the predicate P do not coincide in the same individual. Example: "Some teachers are not doctors." (Robles, 2005).

Logic, especially medieval logic, used mnemonic methods to better disseminate the teaching of Aristotelian logic. What was sought was that the logic of Aristotle was more easily assumed by the student population of those years. This was the case with the words "AfIrmo" and "nEgO" which come from Latin. It translates as "I affirm" and "I deny," respectively. In fact, the highlighted A and I of "AfIrmo" allude to the categorical affirmative propositions, which are "All S is P" (A) and "Some S is P" (I). Likewise, the E and O highlighted from "nEgO" allude to the negative categorical propositions, which are "No S is P" (E) and "Some S is not P" (O). (Copi and Cohen, 2007)

The same goes for BArbArA, CElArEnt, DArII and FErIO, since these four names were associated with the first figure. And by highlighting each of the vowels, one could recall the following four valid syllogisms: 1-AAA, 1-EAE, 1-AII and 1-EIO. Similarly, the second figure was used in the case of CEsArE, CAmEstrEs, FEstInO and BArOcO; for the third figure in the case of DIsAmIs, DAtIsI, BOcArdO and FErIsOn; and, finally, for the fourth figure in the case of CAmEnEs, DImAtIs and FrEsIsOn. According to Kneale and Kneale, this is recorded in William of Shyreswood's Introductiones in Logicam or Summulae Summulae. (1980, p. 218). However, Bocheński also assures that "the expressions Barbara, Celarent, etc., seem almost universally known as early as 1250 (...)" (1985, p. 224)

Problem

The logic course tends to get tricky if one doesn't develop some memory to gain time in solving questions. Particularly, in the field of Aristotelian logic there are mnemonics since medieval times to be able to learn certain contents more easily. An example of this is categorical syllogisms.

The categorical syllogism consists of two premises and one conclusion. Both the premises and the conclusion are categorical propositions. Categorical propositions can be of four types: A, E I and O. Each of these letters are called "typical letters." A stands for the categorical proposition "All S is P." The E stands for the categorical proposition "No S is P." The I corresponds to the categorical proposition "Some S is P". The O corresponds to the categorical proposition "Some S is not P". It should be noted that the use of the letters A, E, I and O already constitute a form of mnemonics.

Now, when the categorical syllogism is ordered, it exhibits a particular structure, where first the major premise is located, then the minor premise and, finally, the conclusion. The major premise (PM) is so named because it contains the term major, which is the predicate of the conclusion. The minor

premise (Pm) receives that name because it contains the term minor, which is the subject of the conclusion. The middle ground is the one that appears repeated in the premises.

Being ordered the syllogism exposes two properties, the figure and the mode, which constitute what is called the logical form (or standard form) of the categorical syllogism. The figure is the position of the mean term (see **Mean** in Table 1) when the syllogism is ordered. This middle ground can occupy four possible positions.

Table 1. The four figures

Medium P	P Medium	**Medium** P	P Medium
Middle S	Middle S	**Medium** S	**Medium** S
S P	S P	S P	S P
Figure 1	Figure 2	Figure 3	Figure 4

Source: Authors.

The mode is the sequence of letters typical of each of the categorical propositions that in their proper order make up the categorical syllogism. Let's look at a case:

PM: Every mathematician is **a scientist**

Pm: No **scientist** is a witch

C : No sorcerer is a mathematician

Its structure is similar to Figure 4, considering that the middle ground is "scientific". In addition, its typical letters in orderly succession are: AEE. Therefore, its logical form is 4-AEE.

Well, in the past, it was necessary to learn the name of each of these in order to distinguish between valid and invalid arguments. In the following table you can see each valid syllogism with its corresponding Greek name in parentheses.

Table 2. Valid syllogisms

1st figure	2nd figure	3rd figure	4th figure
1-AAA (BArbArA)	2-EAE (CEsArE)	3rd (DIsAmIs)	4-AEE (CAmEnEs)
1-EAE (CElArEnt)	2-AEE (CAmEstrEs)	3-AII (DAtIsI)	4th (DImAtIs)
1-AII (DArII)	2-EIO (FEstInO)	3-OAO (BOcArdO)	4-EIO (FrEsIsOn)
1-EIO (FErIO)	2-AOO (BArOcO)	3-EIO (FErIsOn)	

Source: Authors.

The disadvantage of this list for us is that being very far from the Greeks and the medievals these Greek names do not sound at all familiar to us and, therefore, turn out to be totally irrelevant to the subject they were designed. For the above reason, in this work it is proposed that, to learn in a better way these fifteen valid syllogisms, a new mnemonics is applied whose learning greatly favors the

students of the logic course because it would save them time that they could use to solve other types of exercises or to reflect on other issues of a logical nature.

Thus, for the first figure, you have to memorize: "Barbara I will be there yes in 10". This phrase will be highlighted certain vowels so that you understand how to use it and also a bar will be placed to understand how far each syllogism goes: "BArbArA / EstArÉ / AhÍ sÍ / En IO". And, as we know that this is the first figure, the whole previous sentence would represent the following: 1-AAA, 1-SEA, 1-AII and 1-EIO

For the second figure, you have to memorize: "Eva is up in the field at the back." This phrase will be highlighted certain vowels so that you understand how to use it and also a bar will be placed to understand how far each syllogism goes: "EvA is / Up In The / prEdIO / Al fOndO". And, as we know that this is the second figure, the whole previous sentence would represent the following: 2-EAE, 2-AEE, 2-EIO and 2-AOO.

For the third figure, you have to memorize: "Illari there yes please in 10". This phrase will be highlighted certain vowels so that you understand how to use it and also a bar will be placed to understand how far each syllogism goes: "IllArI / AhÍ sÍ / pOr fAvOr / En IO". And, as we know that this is the third figure, the whole previous sentence would represent the following: 3-IAI, 3-AII, 3-OAO and 3-EIO.

Finally, for the fourth figure, you have to memorize: "In front Illari in 10". This phrase will be highlighted certain vowels so that you understand how to use it and also a bar will be placed to understand how far each syllogism goes: "Al frEntE / IllArI / En IO". And, since we know that this is the fourth figure and that there are only three valid syllogisms in that figure, the entire previous sentence would represent the following: 4-AEE, 4-IAI and 4-EIO. It should be noted that this method was exposed on a YouTube channel on January 16, 2023 and has not received the attention of either the teaching community or the logic community (Mora, January 16, 2023). Precisely, this is another reason that justifies writing an article to motivate debate in the academic community.

The use of these four phrases to recall valid syllogisms quickly facilitates the detection of what is a valid syllogism within the parameters of current quantificational logic without considering the existential premise. Let's analyze these phrases: "Barbara I will be there yes in 10", "Eva is up in the property at the back", "Illari there yes please in 10" and "In front Illari in 10". As is evident these four phrases are about certain young ladies who are suggested to stay in a place or are given directions about what to do to get to certain places.

Normally, that is, without relying on mnemonic methods, to detect the validity of a syllogism using Venn diagrams you have to go through the following steps.

Step 1: determine the premises and conclusion. Find the 3 terms.

Step 2: determine the Boolean formula of each categorical proposition.

Step 3: draw the 3 classes (major, minor and middle terms) as well by convention.

Step 4: diagram only the premises. First the universal propositions are graphed and then the particular ones. Thus, the syllogism will be valid if the conclusion appears, is checked or verified.

Let's look at a concrete example:

1) Determine the validity of the following syllogism: "Every Argentine is South American, besides, some logician is Argentine. Therefore, some logician is South American."

First step: determine the premises and conclusion. We have indicated the abbreviation of each of the 3 terms.

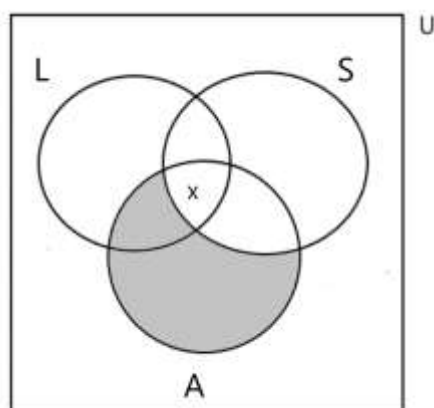PM: All A is S

Pm: <u>Some L is A</u>

   C: Some L is S

Second step: determine the Boolean formula of each categorical proposition.

PM: $A=\overline{S}\phi$

<u>Pm: $LA\neq\phi$</u>

   C: $LS\neq\phi$

Third step: draw the 3 classes (major, minor and middle terms). As you can see, L (minor term) has been placed on the left, S (major term) on the right and A (middle ground) below.

Fourth step: diagram only the premises. The syllogism will only be valid if the conclusion appears, is checked or verified. Here, we see that conclusion C, which indicates that there are elements common to L and S, is indeed diagrammed when we draw the premises. In this case, the syllogism is valid.

Now, using the mnemonic method proposed in this research, one would only have to find the logical form of the syllogism and see whether or not it is located in the list of the 15 valid syllogisms. Analyze.

1) Determine the validity of the following syllogism: "Every Argentine is South American, besides, some logician is Argentine. Therefore, some logician is South American."

First step: We order to locate the logical form to the syllogism

PM: Every Argentine is South American

Pm: <u>Some Logician is Argentine</u>

   C: Some Logician is South American

Now, the logical form of this syllogism is 1 – IIA.

Second step: Based on the figure (which in this case is 1) remember which of the four sentences you would have to use.

As we noticed, it is the first figure. Given this finding, now, we must remember: "BArbArA / EstArÉ / AhÍ sÍ / En IO". This leads us to consider these valid syllogisms of the first figure: 1-AAA, 1-EAE, 1-IIA and 1-EIO.

Third case: Compare the list of valid syllogisms with the case analyzed. If it appears in the list, it is valid. If it does not appear, it is invalid.

Specifically, the third case (1-AII) is the one that matches our example. Thus, we deduce that this is a valid syllogism. Up to this point the use of our method ends.

The students, knowing that it is possible to learn in this way a list of valid syllogisms, have reacted positively, because they recognize that the use of this method considerably reduces their effort, although they also affirm that since memory is fragile it is convenient to learn to solve problems through the use of Venn diagrams. In view of the above, we pose the general question of this work:

Is the Venn diagramming method more or less didactic than the new mnemonics proposed in this work?

Next, we pose two specific questions:

What is the method of Venn diagrams that is still used to teach how to determine the validity of the syllogisms of Aristotelian logic in the light of first-degree quantificational logic?

What is the new mnemonic method that can summarize in a few words the list of 15 valid syllogisms of Aristotelian logic in the light of first-degree quantational logic?

Objectives

The main objective of this research is to compare the method of Venn diagrams with the new mnemonics proposed in this work.

The first specific objective is to expose the method of Venn diagrams that is still used to teach to determine the validity of the syllogisms of Aristotelian logic in the light of first-degree quantational logic.

The second specific objective is to propose a new mnemonics that can summarize in a few words the list of 15 valid syllogisms of Aristotelian logic in the light of first-degree quantificational logic.

Method

This research is carried out under a qualitative approach (Sampieri, Fernández and Baptista, 2014) because it is based on interpreting positions about which method to solve syllogisms is easier. To achieve this, an interview has been used and applied to 10 students out of a total of 45 students of the Legal Logic course of the Catholic University Sedes Sapientiae semester 2023-I. Participants who are only mentioned by some letters such as: MNB, GBT, BLRD, LYB, FNM, SCSM, MAH, JTM, VMD and MPT are kept in reserve and under anonymity. Previously, a learning session has been given with the theme of Aristotelian logic and its main notions and methods and, also explained the method of Venn diagrams to find the validity of syllogisms and the mnemonic method to learn in another way to recognize the syllogistic validity.

Now, we have decided to compare the method of Venn diagrams with the one proposed in this article because the mathematical method of Venn can be reinforced with the knowledge of the 15 valid syllogisms in their primitive form, that is, remembering each of the names of each figure: Barbara, Cesare, Disamis, Camenes, etc. Thus, one can "prove" the validity of each syllogism recorded in Table 2. The idea is that even compared to the reinforced method of Venn diagrams, our mnemonic proposal is superior.

After giving the lesson, the interview is conducted virtually using Meet or, in some cases, Zoom. The most relevant statements expressed by the students themselves for our research have been selected and, based on them, it has been verified whether the method proposed in this work to find syllogistic validity is easier or not than the method of Venn diagrams (which is complemented by the old medieval mnemonics).

The following questions are asked 1. Do you like your logic course in college? Why? Do you know the logic course?

2. How complicated or simple do you find the specific topic of Aristotelian logic? Why? Do you know the 15 categorical syllogisms?

3. Do you know the Venn diagram method for finding the validity of categorical syllogisms? Sound easy? What other method do you know to find the validity of syllogisms?

4. Do you know any of the 15 categorical syllogisms valid in the light of contemporary logic? Can you explain what "1-AAA" means, for example? Can you explain what "Festino" means?

5. Do you know the mnemonic method to find the validity of syllogisms? Sound easy?

6. What method do you find easiest to find the deductive validity of categorical syllogisms? The Venn diagram method or the mnemonic method now proposed? Why?

Results

Some students say that they like the logic course because they understand how to solve the proposed questions and, in addition, because they understand that it relates to the legal topic. This is what MNB and GBT think. BLRD says that at first it did not seem easy, but over time he has understood it. He also recognizes that he has not yet fully mastered the subject of syllogisms to such an extent that he only clearly remembers the concepts of quality and quantity of them. LYB claims that the course helps him reason. FNM maintains that it does feel that it is learning and, in addition, recognizes the effectiveness of logical knowledge. Interestingly, SCSM considers that the course serves to interpret legal laws, because, for this person, logic is not only mathematics.

Almost everyone claims that Aristotelian logic seems complicated to them or they simply do not know it well. Most claim to know the syllogisms, but they cannot explain it. This occurs with MNB and GBT. They may not understand some fundamental concepts of syllogisms, but they can point out what the valid syllogisms are. In the case of LYB, he acknowledges that he does not practice as he should to better understand the subject. A particular case is that of FNM who could even give an example of the "Festino" syllogism. Likewise, MAH states that Aristotle's logic is interesting and that it does not seem so complicated because he understands Venn's idea of class diagramming. Even JTM understands the distinction between mode and figure that characterizes the categorical syllogism. Also, SCSM mentions the syllogism "Camestres" as something typical of Aristotelian logic, but also fails to clearly define what figure it is.

The vast majority claim that the mnemonic method proposed in this paper is easier to apply than the Venn diagram method because it is shorter. Thus, it is maintained, for example, by MNB and GBT. Also, VMD states that the proposed method makes "rhymes" with which it allows it to more easily remember valid syllogisms. MPT understands that with nmnemonics it can remember the basic forms of valid syllogisms in such a way that, if a syllogism does not match that form, then it is not valid. Interestingly, SCSM points out that mnemonics is easier because people might get confused when shading a region on the Venn diagram. Even JTM claims that this new method does not take long to be able to have an immediate response.

Discussion

Although the results have supported the main idea that the mnemonic method proposed in this article is simpler and easier to apply than the Venn diagram method, it is important to make some final reflection.

The advantage of the Venn diagramming method is that it allows you to understand why a syllogism is valid or not. Precisely, the fact of learning to shade or put an X over a section or area of the Venn diagram and then interpret whether or not what is drawn coincides with the proposed conclusion is what allows us to understand the modern sense of Aristotle's logic.

However, it should be noted that Aristotle himself did not apply Venn diagrams to detect syllogistic validity. In reality, he applied a list of 8 rules that determined when a syllogism was valid or not. Next, we share them:

1. Obvious rules:

A1. Every syllogism must contain only three terms (major, minor and medium).

A2. The middle ground should only be contained in the premises, never in the conclusion.

A3. The conclusion is constructed with the weak characteristics of the premises, being understood as weak to the particular or negative characteristic. (...)

2. Rules of Terms:

A4. The middle ground must be distributed in at least one of the premises.

A5. If in the valid syllogism there is a term distributed in the conclusion, it must be distributed in its respective premise.

3. Quality rules:

A6. If both premises are affirmative, there can be no negative conclusion. A syllogism constructed in this way is invalid.

A7. If the two premises are negative, nothing follows. A syllogism constructed in this way is invalid.

4. Quantity rule:

A8. If the two premises are particular, nothing is concluded. A syllogism constructed in this way is invalid. (Mora, 2020, pp. 13-14)

It is to some extent evident that Aristotle also demanded of his followers that they have cultivated the memory in order to learn so many rules and thus detect whether or not a syllogism was valid. Now, if it is a question of exercising memory, the mnemonic method proposed in this work could be accepted on condition that the method of Venn diagrams is previously handled and the rote method is applied as a last resort. The idea is that knowledge of a subject such as logic is supported by conscious learning and not simply by a repetition of previously learned formulas. The dignity of logic must not be reduced to being a merely rote course.

Conclusions

The research yielded the following conclusions. The Venn diagramming method is less didactic than the new mnemonics proposed in this work. The old medieval mnemonics, which is still used to teach the validity of the 15 valid syllogisms of Aristotelian logic in the light of first-degree quantificational logic, is outdated and should be updated to benefit the teaching-learning process of logic, but without neglecting the knowledge of Venn diagrams. The new mnemonic method, which can summarize in a few words the list of 15 valid syllogisms of Aristotelian logic in the light of first-degree quantational logic, is more effective and this is confirmed by the testimony of its own users. Finally, it can be said that medieval mnemonics such as Barbara or Festino, are obsolete compared to the one proposed in this same writing.

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