



Creativity and mathematical knowledge in the Plato's *Ion*

Criatividade e o conhecimento matemático no *Íon*, de Platão

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Abstract

The aim of this historical-philosophical study is to clarify the understanding of creativity according to Plato, to whom is attributed a conception associated with poetic activity and divine inspiration. The main source of this notion is the dialogue *Ion*, in which the philosopher criticizes rhapsodies and poets for not having a technique. Among some techniques presented in *Ion* as contrast is the arithmetic technique. Which directs the research to the elucidation of what Plato understood by technique and expands the list of consulted dialogues. The methodology employed is configured as a hybridism between different trends in Mathematics Education, such as studies on creativity, the history of mathematics, and hermeneutics. The conclusion locates Plato's critique of poetic activity within the framework of Plato's epistemological program to improve its interpretation.

Keywords: Creativity; Mathematical Knowledge; Plato; History.

Resumo

O objetivo deste estudo histórico-filosófico é esclarecer a compreensão da criatividade segundo Platão, a quem é atribuída uma concepção associada à atividade poética e à inspiração divina. A principal fonte dessa noção é o diálogo *Íon*, em que o filósofo critica rapsodos e poetas, por não possuírem uma técnica. Entre algumas das técnicas apresentadas no *Íon* como contraste está a técnica aritmética, o que dirige a pesquisa à elucidação do que Platão entendia por técnica e amplia o elenco de diálogos consultados. A metodologia empregada configura-se como um hibridismo de diferentes tendências da Educação Matemática, como os estudos sobre criatividade, a história da matemática e a hermenêutica. A conclusão localiza a crítica de Platão à atividade poética no panorama do programa epistemológico de Platão, de modo a aprimorar sua interpretação.

Palavras-chave: Criatividade; Conhecimento Matemático; Platão; História.

Introduction

There is no single, widely-accepted definition of creativity; rather, it is a concept that has been studied and grounded in various fields such as psychology, philosophy, education, and the arts. Each day, we utilize some form of creativity, oftentimes without scrutinizing its

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meanings and the associated processes involved.

When we choose to subject our thinking to a rigorous methodology defined by the application of explicit methods, we are leaving a casual attitude and common sense behind in favor of adopting a scientific or philosophical approach. Once we set criteria that consider historical and discursive aspects, as well as the production and interpretation contexts of knowledge, fundamental questions arise and develop. For instance, borrowing Mendes' (2013) question, how can we describe creativity while considering the requirement to utilize specific cognitive abilities to generate novel information? (p. 187). Moreover, in what ways does creativity display itself? Is it feasible to evaluate and cultivate creativity? The concept of creativity has gained prominence in Mathematics Education research. Our goal is to advance our understanding of creativity and its instrumental use through theoretical and methodological applications. We strive to contribute to the development of this concept. This is what we gather from research conducted by Glăveanu (2010), Gontijo et al. (2019), Lubart (2007), and Silva et al. (2022) on the various conceptions of creativity that we strive to align with. Certain queries by these authors foster a constant pursuit of elucidating the concept, its alterations, and its roots, leading to a better comprehension. Gontijo et al. (2019) argue that discussing creativity in mathematics is crucial because the discipline is paradoxically considered difficult, impossible to learn, or exclusive to geniuses. Developing the creative potential of math students has become a concern in educational policies. They assert that creative skills can and should be nurtured in math students. In a rapidly changing society, schools serve as a crucial training ground for individuals equipped to mobilize resources and create innovative solutions to problems in personal, social, and professional spheres. Valuing creativity in these domains enables the development of new products and services for a broader population. The "systemic approach to creativity" proposed in Silva et al.'s (2022) study maps Brazilian journals and publications on creativity and identifies multiple conceptions related to teaching mathematics. Methodologies proposed include Mathematical Modeling, Problem Solving, and the History of Mathematics (p. 101). The study we propose here is part of a range of approaches that combine History and Philosophy. According to Silva et al.'s (2022) "systemic approach to creativity," a map of Brazilian creativity journals and publications shows a "variety of conceptions being used in studies on creativity that relate to mathematics teaching" (p. 101). Among the various proposed methodologies, Mathematical Modeling, Problem Solving, and the History of Mathematics stand out. Our research is aligned with this plurality of approaches, integrating History and Philosophy.

Examining the history of creativity studies, Glăveanu (2010) outlined "three paradigmatic stages" (p. 80), including the stage of the genius, the creative person, and the social stage.

Investigations into the relationships between creative people, processes, products, and environments have roots in historical times predating the consolidation of psychology as a science. Investigations into the relationships between creative people, processes, products, and environments have roots in historical times predating the consolidation of psychology as a science. However, conducting a thorough examination of these roots requires the

application of diverse methodological tools that yield analyses revealing varied interpretations. Objective evaluations are crucial in this endeavor.

Objective

This research aims to provide a short overview of creativity in Plato's philosophy. It is based on reviews of Lubart's (2007) and Gontijo et al.'s (2019) works, which mention Plato's brief allusions to creativity. However, these authors do not delve into Plato's thoughts to scrutinize what could be seen as creativity. Therefore, this study aims to fill a gap in the field of creativity by conducting theoretical and exploratory research with a historical-philosophical approach. The goal is to deepen the debate and provide a deeper understanding of the problem. According to Plat Lubart (2007), Plato stated that a poet needs inspiration and desire from the muse to create. The poet, who is considered extraordinary as the gods chose him, shares the creative ideas he has received. Gontijo et al. (2019) highlight that

creativity's origin lies in a mystical approach that regarded it as a divine or spiritual gift, which bestowed some individuals with superior creative power. Plato's portrayals of the muse who inspires poets reveal this concept (p. 19).

Some questions arise from the quotes about where Plato's idea of creativity is found. Specifically, what text explores the relationship between creativity and poetry? Does Plato reaffirm this idea in more than one dialogue? What are the contexts and storylines in which these judgments are made? Are there other related concepts? How does this concept relate to mathematical knowledge?

The paths to finding the answers to these questions focus on the words Plato used and how they relate to creativity. We analyze the specific meanings of these words, but their definition ultimately depends on the context in which they are used. We analyze the specific meanings of these words, but their definition ultimately depends on the context in which they are used. This leads us to explore the cultural aspects of Ancient Greece, such as poetry and mathematics, which Plato interpreted within his epistemological program. We analyze the specific meanings of these words, but their definition ultimately depends on the context in which they are used.

As we can see, the sources bring up many significant questions that can inform current research. Therefore, the methods used to find answers are just as crucial as the solutions themselves.

Searching for a Greek word for creativity

The ancient Greeks didn't have a specific word for creativity; in other words, the very concept of creativity was nonexistent among them. Nowadays, according to the *Priberam Online Portuguese Dictionary*, creativity is defined as: "(1) the ability to create, to invent; (2) the quality of one who has original ideas, of one who is creative" (Priberam, n.d.). The verb *criar*, on the other hand, derives from the Latin *creo*, which has the meaning of to create, to

bring into being, to make, to generate, to produce (Latin Dictionary, 2012). The Online Etymology Dictionary refers to the use of creativity from the 19th century onwards, and an encyclopedia we consulted (Treccani, n. d.) adds to this and credits the American psychologist Joy Paul Guilford (1897-1987) with initiating studies into creative intelligence by spreading the term in his works.

So what was the term used by Plato to refer to creative activity? It is the verb *poiéō*², which means to create, to make, to produce, to bring into being, and gives rise to the noun *poiēsis*, creation, method of production, which, adapted to Latin, gives rise to the word “poetry.” With this in mind, the research focuses on dialogues in which the theme of poetry is present. And although poetry is discussed in some dialogues, such as *The Republic and The Banquet*, Plato made it the governing motif in the *Ion*, which we will deal with next.

Creativity as a divine possession of the muses

The character *Ion*³ is described as a rhapsody, a profession that in Ancient Greece consisted of reciting poetry, particularly Homeric poems. The rhapsody, adorned in beautiful clothes and accompanied by the sound of the lyre, recited the poems from memory on a kind of stage, using acting resources (Platone, 2010, p. 1022).

In this dialogue, it is said that “all poets of epic verse” make their compositions “not by virtue of technique [*tékhnē*], but by being enthusiastic [*étheoi*] and possessed [*katekhómēnoi*] [emphasis added]” (Plato, 2011a, pp. 38-39). The affirmation of the poet’s activity as the result of enthusiasm or inspiration from the gods is mentioned throughout the dialogue, and other expressions are associated with it, such as “divine concession” (*theíai moírai*) or “divine power” (*theíai dynámei*). In this way, the poet is a passive agent of creation, a vehicle at the service of God who transcribes what is transmitted to him.

Plato draws an analogy between the poet and the oracle: in both, the rapture becomes language, and, just as it is up to the person who has received the message from the oracle to interpret it, it is up to the rhapsody to interpret the poet’s beautiful verses. For Plato (2011a), rhapsodies are “interpreters of interpreters” (p. 41). Like the poet, the rhapsody is also possessed by a divine inspiration - both “are possessed and not possessors in relation to the things they express” (Schäfer, 2012, p. 256).

In the *Ion*, we find Socrates referring to the ability of a magnet to attract iron rings capable of connecting into a series of rings (Plato, 2011a, p. 37). The philosopher’s purpose is to establish a relationship between magnetism and the overflow of self that the poet experiences through the inspiration of the muse. The poet’s enthusiasm magnetizes the rhapsody, leading him to also experience enthusiasm during his performance. In turn, the rhapsody produces the same effects in his spectators. This is what Socrates says:

² Here we follow the Greek transliteration rules established by Prado (2006).

³ In order to avoid possible confusion due to homonymy, we will refer to Plato’s dialog in italics (*Ion*) and to his character in common spelling (*Ion*).

You know, then, that this spectator is the last of the rings of which I spoke ... the middle one is you, the rhapsody and actor; the first, the poet himself; but the god, through all these rings, drags the souls of men wherever he wishes, making power hang between them. (Plato, 2011a, p. 37)

In this passage, we see a dominant power that flows from one individual to another, a state of frenzy that radiates out. Under these conditions, what is commonly interpreted as the creativity of the poet and the rhapsody are transferred to the audience, providing a state of collective ecstasy. Plato's criticism of poetry is based on the distinction between reason (*lógos*) and myth (*mýthos*). The latter represents the archaic paradigm for obtaining knowledge, while the former marks the skeptical and rationalist stance that gives rise to classical thought. What is at stake for Plato is a criterion of value between *truths* of different natures: one of them, myth, is restricted to belief and linked to ancient religious traditions, while the other - reason - has its nexus in political and discursive practices, in which the persuasion of the interlocutor (or the audience) does not take place through the force of a greater authority, exempt from explanations or justifications, but through the capacity for reasoning. Without loss of generality, it is this same argumentative-persuasive competence that is at the origin of mathematical demonstrations - an intrinsic characteristic of Greek mathematics, another cultural product of the classical period.

Unlike arithmetic, the activities of the poet and the rhapsody are not techniques.

The core of the discussion in the *Ion* is Socrates' attempt to persuade the rhapsody that the knowledge he claims to possess is not knowledge. Socrates distinguishes poetry and rhapsody from technique (*tékhnē*, also translated as art) and science (*epistēmēi*, also translated as knowledge). Examples of various techniques are given and compared with the activities of the poet and the rhapsody. The first example is the arithmetic technique (*arithmētikēn tékhnēn*) (Plato, 2011a, p. 31), followed by medicine, painting, and sculpture. The way it is interpreted in this dialogue, a technique comprises the whole of a subject (p. 35), and the artist - or technician (*tekhnikós*) - is recognized as the one who has knowledge and mastery of that subject. They know how to recognize the competence of another person performing the same function, and have the ability to appreciate and make a value judgment regarding the result of someone else's technique. "When many people are talking about numbers and a certain person says things better, will anyone undoubtedly recognize the one who speaks eloquently?" Socrates asks and adds, "Exactly the same person who will also recognize those who speak badly or someone else?" (Plato, 2011a, p. 31).

As Cambiano (1991) explains, "techniques are examples of what knowledge means" (p. 66). Still, according to the same author, "what allows them to possess such a qualification consists, according to Plato, in the delimitation of a field of competence". The modern notion of "field" as an "articulated set of parts connected to each other" (p. 68) corresponds to what Plato calls "the whole" (*hólon*), in other words, everything that can be known about a specific

subject, restricted to its field of competence. Understanding what such a field of activity is involves clarifying the objects that make it up, which makes it possible to determine who the person with the qualification is, the technician. Therefore, the certification of a certain individual as possessing a technique is subject to the certification of its objects and the delimitation of its field of activity. The Platonic consideration of techniques as "objective" operations even implies the use of theories that techniques have developed about their own procedures (p. 67).

At the opening of the dialog, Ion presents himself as the greatest connoisseur of Homer's poems, limiting his ability to the poet's verses. Socrates then asks him how he cannot be competent to speak about the poems of Hesiod or Archilochus, since they deal with the same things as Homer. If Ion considers his work as a rhapsode to be a technique, then his knowledge should encompass the whole of poetry, which would allow him to evaluate the works of any poet.

Converting this argument to the technique of arithmetic in Plato's time, an individual who is competent in arithmetic will be able to recognize what the various mathematicians say about it. Anyone wishing to become a technician in arithmetic should aim to know the whole of it, not just the work of a particular arithmetician. Therefore, arithmetic technique, understood as a field, is delimited by its objects, numbers, and includes theories of calculation, its methods, and its rules of operation. Mastery of the technique enables its holder to have a capacity for discernment, that is, an exercise in criticism that qualifies a product of another person's arithmetic technique as good or bad.

The dialog *Philebus* contains some reflections on the intertwining of theory and practice in technical activity. The practical part is described through instruments: "in building ships, houses and the many other branches of carpentry. For, I believe, in these constructions there is the use of the ruler, the lathe, the compass, the string and the use of an ingenious kind of square" (Plato, 2012, p. 171). Knowledge, in turn, leads to expertise in the use of instruments, ensuring the accuracy of measurements and calculations, and, in general, obtaining information for building or solving a problem. In its role as the conductor of practice, knowledge has, for Plato, a higher epistemological status. "For example, if we take away from any of the techniques the technique of numbers, the technique of measurement, and the technique of weight, what will remain in each of them would be, so to speak, valueless" (p. 171). Commenting on "a creative process from a social point of view", Leikin and Pitta-Pantazi (2012) state that "creativity emerges from a complex interactional process" (p. 161). In their text, psychological-behavioral and personal characteristics of creative individuals, such as intuition, curiosity, among others, constitute the elements that interact in this process. However, "Plato's educational project involves the passage from the sensible to the intelligible" (Paviani, 2008, p. 57) and, from this angle, the interactional process between knowing (theory) and doing (practice) is interpreted.

Another argument used in favor of the thesis that the activity of the rhapsody cannot be a technique is that the poems speak of things about which neither the poet nor the

rhapsody has any knowledge. For example, in the *Ion*, Socrates quotes a passage from canto XXIII of the *Iliad*, which deals with the technique of driving chariots (Plato, 2011a, p. 47). The question posed by Socrates is whether there is a better person to judge the correctness or otherwise of this matter than someone who has the technique of chariot driving. Similarly, a passage from Canto XI, which describes the preparation of a potion to be given to a wounded soldier (pp. 49-51) raises the question of who is better than a doctor to judge its correctness. And a fragment from Canto XXIV, quoted by Socrates in the same passage, raises a similar question about the technique of fishing. Other examples are given in the dialogue, such as those of the general, the carpenter, the sitarist and, of course, the arithmetician. So the poet and the rhapsody describe the actions of different technicians in their fantastic narratives, but they themselves don't have the knowledge of what they're talking about. Once again, a circular element of the *Ion* is that only one specialist can give an opinion on the work of another because it is up to them to recognize the skills inherent in the technique in question. This recognition of experts is present in Leikin and Pitta-Pantazi (2012), when they say that "creative ideas are those that are considered by the social group of reference to be new and significant in a specific field" (p. 161).

Finally, the notion that the poet and the rhapsody cannot be technicians because they do not possess true knowledge is associated with another problematic of Platonic epistemology, which concerns whether the technician can give the reasons for his knowledge and explain by what processes this occurs. This link is not explicitly established in the *Ion*, but it is widespread in other dialogues.

Mathematical sciences are techniques, but they are not knowledge

A central topic in Platonic epistemology is that of obtaining knowledge. The mathematical sciences (geometry, arithmetic, astronomy and music) play a fundamental role in mediating between opinion (*dóxa*) and knowledge (*epistémē*), as can be seen in Book VII of the *Republic*: Plato made a distinction between two worlds, that of sensible reality and that of intelligible reality. In the real world, shadows, reflections, and imperfect and corruptible copies predominate. Thus, our apprehensions occur through the exercise of the senses, which limit us to issuing mere opinions about things. In the realm of the intelligible, the light of ideas prevails, which are the essences of things, immutable and incorruptible and apprehended by the faculty of reason.

It is this division that the metaphor of the divided line deals with, in which Plato (2006) establishes the relationship between the various levels of knowledge and the realities associated with them. "Take a line divided into two unequal sections and, again, cut each section according to the same proportion, that of the visible and that of the intelligible" (p. 261), says Socrates to his interlocutor. Therefore, the part relating to sensible reality is divided into two other parts, which in turn concern opinion and belief. The same happens with the part of the line that represents the intelligible, divided into two others, one of which corresponds to mathematical knowledge (*dianoia*) and the other to intelligence, to ideas

(*noēsis*).

We can better understand the intermediate position of mathematics from a criticism that Plato (2006) makes of the language used by mathematicians:

Those experienced in geometry will not dispute with us that this science is quite the opposite of what those who practice it say in their speeches. ... Because those who practice it and have it as a justification for their actions, when making their statements, talk about squaring, constructing a figure, and adding, always using terms like these. ... So we should agree on that too? That it has in mind what always is and not what comes to be and perishes. ... Geometry is the knowledge of that which is always there (pp. 284-285).

When interpreted for today's classroom, the comment criticizes the math teacher who draws a figure on the blackboard and names it "this is a triangle" or "this is a circle", and gives the definition of this object to his students. When he draws other figures of the same type, but of different sizes and positions (in the case of rectilinear figures), and asks "is this a triangle/circle?", the teacher expects an affirmative answer from his students. But how can they be the *same* figure? Or, following the definitions, it would be possible to check with a ruler of millimetric precision that the points of the circle are not exactly equidistant from the center, or, with a protractor, to check that the exact sum of the angles of the triangle drawn on the blackboard does not result in two right angles.

What Plato (2006) points out is that the mathematician uses representations and talks about them, but his discourse is hybrid because he is thinking about perfect figures - in Plato's words, "the figure itself" or "the idea of figure". And these are the figures that the student "visualizes with his mind" while drawing, exploring and solving exercises. This also applies to the objects of arithmetic: "they speak of numbers that can only be thought of and cannot be treated in any other way" (p. 283). In general, "science admits nothing that is sensible" (p. 288). Plato appreciated mathematics and took it as a model for philosophy because it was a precise and anti-relativistic type of thinking, even if it used relative objects. And he sought, for philosophy, the precision and generality of mathematical concepts, the subject of the dialog *Theaetetus*, in which we see a critique of Protagoras' relativism with the participation of the mathematicians Theodorus and Theaetetus.

It's worth noting that the problem can be solved through language, another axis of Platonic philosophy. Each figure drawn by the mathematician is a figure, and not simply a figure. The definition encompasses the multiplicity of individual cases and serves as an archetype for each of them. As Bicudo (1998) explains, "the question is how to use words correctly, not to seduce, but to discover the truth. This is the problem that Plato faces, it is the very problem of philosophy" (p. 75).

In Plato's metaphysical scheme, mathematics is above dialectics because mathematics is limited by hypotheses - in other words, mathematical research assumes hypotheses and starts from them towards conclusions. However much a mathematician may boast about the precise and elliptical definitions of his science, they are based on an agreement, a conviction that, strictly speaking, does not have the status of truth. That's why Plato (2006) tells Socrates

that "geometry and those that derive from it ... dream of being", but "using hypotheses, they leave it untouched because they are incapable of accounting for them" (p. 293). The search for a safe heuristic harbor led Plato to formulate the "idea of the good", a "non-hypothetical principle" that could only be reached through the ascending path of dialectics. "Only the dialectical method, by eliminating hypotheses, moves in this direction, towards the principle itself, to give firmness to the results" (p. 294). In Plato's philosophical scheme, dialectics provides the reasons for the hypotheses.

Consequently, even though mathematics is the *thékhnē* that comes closest to *epistēmē*, it can only be reached through dialectics. Through its methods, mathematics is the prelude to dialectics, its gateway (Bicudo, 1998).

The geometry lesson and mathematical knowledge

Mathematicians use numbers and ideal figures in their reasoning, and their starting point is hypotheses. It remains to be explained how these things fit together and result in knowledge.

One of the most paradigmatic passages on the role of mathematics in Plato's philosophy can be found in the *Ménon*. In it, Socrates questions a young slave about the duplication of a square (Plato, 2009, pp. 55-63). The problem in question deals in its reasoning with the relationship between quantities - after all, if we know the length of the side of a given square, how can we calculate the side of the square that has twice the area? The arithmetic approach proves insufficient to solve the question, making it necessary to treat incommensurable geometrically. Analyzing the mathematical terminology of the passage, we see that Plato stops asking the slave to "calculate [*logisámenos*] and say" (p. 55), and starts suggesting that he show the size (*pēlikēn*) of the side of the double square. The epistemological framework for this episode is the question of the possibility of transmitting and using knowledge or a technique.

The flourishing of vast literature of manuals in Greece at the end of the fifth century before the Common Era (BCE) led to the belief that the transmission of the rules of a technique consisted of the simple transmission of its information by an expert (Cambiano, 1991, p. 117). The "communication of professional knowledge and skills, the whole of which, insofar as it is transmissible, the Greeks called *techne*" (Jaeger, 2001, p. 23). The manuals provided theoretical knowledge of the rules of a field of activity, but they proved to be insufficient in terms of the use of these rules and also in terms of the ability to use them correctly, which could only be learned in everyday life with a technically qualified master. For Plato, "knowledge is a domain that lies at the limit of a process of investigation, and is therefore susceptible to acquisition and loss" (Cambiano, 1991, p. 121). There are two conditions for research to take place: i) recognizing the lack of knowledge for those who wish to know, and ii) knowing how to search. The first manifests itself at the end of several dialogues, after the repeated use of the method of refutation (*élenkhos*), characteristic of Socrates, when he questioned his interlocutors about the definition of a concept and obtained

from those particular cases, instantiations of the concept sought. The second is more difficult, as it depends on a dialogical-dialectical process that writing is unable to reproduce in its most authentic form - a theme developed in the dialog *Phaedrus* and in *Letter VII*.

So, in the *Ménon*, Socrates sets out to demonstrate his thesis: "What we call learning is recollection" (Plato, 2009, p. 53). The character chosen to take part in the process is a young slave, a significant protagonist of the minimum requirements for learning (*manthánō*) or recollection (*anámnesis*) to occur. Therefore, these requirements are, on the one hand, knowledge of the common language (in this case, Greek) and, on the other, knowledge of the basic objects of geometry, such as squares and rectangles, and the calculation of the area of these figures (pp. 53-55). Where would creativity be in this process? How does it manifest itself?

Plato's answer lies in the connection or chain (*desmōi*) that the learner establishes between the properties of geometric objects, which can be interpreted as a process of inference that Plato (2009, p. 103) calls "causal calculation" (*aitías logismós*). This process is carried out with the help of figures, diagrams and auxiliary constructions, as well as according to the instructions given by Socrates. From this point of view, creativity is an inherent characteristic of a method.

In time, the geometry practiced by the Greeks was a hybrid technique that combined vision with discursive thinking. It is enough to check the presence of demonstrative pronouns in the passage in question: "these lines", "this side", "equal lines like these", "every line of this surface", etc. (Plato, 2009, p. 55). Plato's text describes a dynamic activity in which figures are drawn in the course of the dialogue. The same tradition, but without the dialogical spontaneity, can also be found in Euclid's *Elements* (2009), where each of the propositions is accompanied by a diagram.

Ultimately, the solution to the problem of knowledge in *Ménon* is that the slave has recovered knowledge that was latent in his soul-the theory of reminiscence, a Pythagorean element rescued and reinterpreted by Plato. No one had ever taught geometry to the slave before, so the result obtained could be "something external, something deposited in the soul or spirit as if it were an empty vessel" (Paviani, 2008, p. 72). *The theory of reminiscence* presupposes the immortality of the soul, its pre-existence in relation to the body, and a pre-knowledge of all the truths that souls possess in their incorporeal state, as stated in *Ménon*. From this point of view, being born means forgetting. "Before its incarnation in the present existence, the soul was in contact with that which it had to acquire knowledge of, as if it had always been, de facto as well as de jure, a recognition" (Mattéi, 2010, p. 74).

It remains to be seen how reminiscence provides the reasons for the connections between the geometric elements that, stage by stage, lead to the solution of the problem in a clear passage from one state of knowledge to another. And if the solution to a problem is the final stage sought by the investigation, what would be at the beginning of the connections? In this regard, Socrates resorts to the mathematical procedure of hypotheses (*ex hypothéseōs*). "By 'from a hypothesis' I mean the way geometers often conduct their investigations" (Plato,

2009, p. 69).

The search for the solution to a problem or the demonstration of a theorem does not take place *ex nihilo*. Initial conditions are established by assuming the existence of fundamental objects whose reasons cannot be derived from simpler ones. This is basically the meaning of hypothesis, "what the participants in a (rhetorical) debate agree to accept as the basis and starting point of each other's argument" (Euclid, 2009, p. 87). A hypothesis is a proposition accepted without demonstration, from which one can deductively verify the consequences of a conclusion. Its synonyms are axiom (*axiōma*) and postulate (*hóron*, a term used by Euclid in the *Elements*). In mathematics, establishing a hypothesis means assuming certain objects, properties or even previously proven results. The epistemological function of hypotheses is that they are used in demonstrations, but not to be demonstrated.

Those who deal with geometry, calculations and subjects like these hypothesize about odd and even, figures, three kinds of angles and the like, according to their research. ... And on the one hand ... they think they don't have to answer themselves or others about it. ... and, on the other hand, starting from these hypotheses ... in a consequent manner, they end up arriving at the demonstration. (Plato, 2006, pp. 262-263)

Adapted to philosophy, this hypothetical method does not assume indemonstrable principles, but an initial condition of solubility for the question in question.

In general, hypotheses are not suppositions endowed with an ultimate foundation, but rather have a certain plausibility, which guarantees them broad knowledge, without being guaranteed by proof because hypotheses are presuppositions of an argument only if the interlocutor has consented. (Schäfer, 2012, p. 148)

As we can see, the question of the transmission of a technique in Plato's philosophy cannot be cut off from its framework of relationships, in which reminiscence, the hypothetical method and the method of questions and answers are articulated, brought together around a common search for the one who wishes to learn and the technician. It is in this context that creativity becomes a piece that has to fit together.

Plato's creative mathematical god

The *Timaeus* is Plato's cosmogony. Unlike cosmology, which is defined as the science of the laws that govern the universe, cosmogony uses myths to describe the creation of the world, either by the will of a deity separate from the world, or from primordial elements of nature. Cosmogony deals with the passage from chaos to order (*kósmos*), based on mythical narratives. In *Timaeus*, Plato (2011b) articulates the theistic and naturalistic theories and justifies their organization with mathematics. To this end, the philosopher postulates a figure, the demiurge (*dēmiourgós*), a god (*theós*) different from those of Olympus, since he is described as good and free from envy (p. 97). The meaning of demiurge is precisely that of creator, fabricator, and builder, and the word used to define him is *poiētēs*, "the creator and father of the world" (p. 95). If in the *Ion* the muses are responsible for poetic creation, in the *Timaeus* the god himself exercises creativity. If in the *Ion* the technicians can recognize and judge the work of their peers, in the *Timaeus* the activity of the demiurge determines the

paradigm for the use of technique. It is not up to men to question the demiurge's creative activity, although they can recognize his technical skill in organizing the universe, and aim to reproduce his high degree of application of techniques.

The demiurge's methodology "is described in the light of human criteria, for he discovers through reasoning" (Plato, 2011b, p. 39). His activity consists of applying mathematical proportion and harmony and bringing order to everything that is disordered and moves irregularly. Fire, water, earth and air "began to be configured through shapes and numbers" (p. 140). The shapes in question are basically right-angled, equilateral and isosceles triangles, used to make geometric solids. Without having the concept of creativity itself, what we read in *Timaeus* is a description of a creative activity in which the demiurge formalizes or models the universe, justifying his choices, manifesting his knowledge.

The characterization of the demiurge is closer to that of men since his creative work is directly related to various techniques. Described by Schäfer (2012, p. 76) as an expert craftsman in many techniques, the demiurge acts like a blacksmith who applies the spherical shape to the universe because "of all figures, this is the most perfect and similar to itself" (Plato, 2011b, p. 102). Next, each primordial element is represented by a geometric solid: earth - cube; water - icosahedron; air - octahedron; fire - tetrahedron (pyramid) (pp. 143-146). The dodecahedron, made up of 12 pentagons, is the closest to the sphere, and, as the symbols of the Zodiac are also 12, the interpretation given to the dodecahedron is that of the organization of the stars (p. 144). In time, the Zodiac is the set formed by 12 constellations represented by animals. The construction of each of these solids can be found in the last book (XIII) of Euclid's *Elements*: tetrahedron (Proposition 13), octahedron (Proposition 14), cube (Proposition 15), icosahedron (Proposition 16) and dodecahedron (Proposition 17) (Euclid, 2009, pp. 577-592). And each of them is built inside a sphere.

In the passage from the *Timaeus* in which he mentions the Zodiac, Plato (2011b) attributes to the demiurge the painter's technique: "to paint animals in the universe" (p. 144). In addition to this, the demiurge also possesses the techniques of a wax modeler and potter (pp. 177-178), weaver (p. 185) and farmer (pp. 177-179). However, the mathematical technique is by far the most present throughout the dialogue. The *Timaeus* is the major source of the Platonic representation of mathematics as a divine creation.

Methodological epilogue

The justification for placing the section on methodology at the end of this text lies in the belief that it may be more useful for the reader to identify a form, having already checked its content. In other words, in this specific case, it is considered appropriate to describe the instruments and delimit the methodological contours of the research after it has been carried out.

Defined as a theoretical study of a historical-philosophical nature, this work is based on bibliographical sources and their interpretation. If, in *Ion*, Plato considers the poet to be an interpreter of the gods, and the rhapsody an interpreter of the poets - and therefore an

interpreter of interpreters - we, in our analysis of the dialogue, are interpreters of interpreters.

"After the Bible, Plato is the most important object of interpretation in the Western tradition" (Hösle, 2008, p. 39). The hermeneutic activity of Plato's works was born in the Academy itself, where its first interpreters were his most prominent disciples: Speusippus and Xenocrates, who went on to head the Academy after the master's death, and Aristotle, who founded his own school, the Lyceum. This tradition lasted until the end of the 18th century, when the German Friedrich D. E. Schleiermacher (1768-1834) developed rational precepts for philology. In his method, historical interpretation took center stage, as he believed that, in addition to the specific characteristics of the ancient Greek language, it was necessary to consider the time and culture in which the text was composed. To deal with the significant difficulties of the Platonic text, he proposed two complementary fronts of reading: the systematic and the fragmentary (Schleiermacher, 2002, p. 32).

The fragmentary "deals with individual analyses and seeks to make philosophy comprehensible from loose fragments" (Schleiermacher, 2002, p. 32). In our case, individuality translates into a thematic choice (creativity), based on a specific dialog (the *Ion*), which deals with the relationship between a creative person and their creative product. One advantage of this perspective is that it "defines and designates its objective in advance and moves directly towards it" (p. 33).

Reading the *Ion* in the light of a critical analysis of creative activity allows us to outline a meaning of creativity that overlaps Platonic epistemology with myth. Initially, "the problematic, the questions, the objects of discussion, the argument, the plan and the notions must therefore be deduced from the text, established by the text" (Folscheid & Wunenburger, 2006, p. 109). However, the understanding of creativity is related to frequent concepts in other works by Plato. Instead of seeking a definition for creativity, Plato excludes it from the realm of *technique and knowledge*, so it is necessary to understand the meaning of these concepts, which in turn requires consulting general works, such as Plato's lexicon (Schäfer, 2012), in order to "review the structure of the meaning of the notion" (Folscheid & Wunenburger, 2006, p. 251). The next step in this inductive process is to verify and contextualize passages from other dialogues in which Plato discusses technique and knowledge.

Without realizing it, the work moves into the other reading perspective proposed by Schleiermacher (2002), the *systematic* one, characterized "by dividing the whole area into various special knowledges" (p. 32). There are various levels of reading Plato's works, for example, the political, the metaphysical, the epistemological and the pedagogical. In each of them, the works of greatest interest are selected, which serve as a ground plan for a reconstruction of the philosopher's thought. This compartmentalization of Plato's philosophy into disciplines is not intended to reduce or disaggregate it, since "none of his writings is specifically limited to one of these disciplines" (Schleiermacher, 2002, p. 33). On the contrary, Plato conveys an image in which "the philosopher or dialectician is the one who knows how to divide and reunite, examine the parts without losing sight of the whole"

(Paviani, 2008, p. 24).

Therefore, research into creativity is part of Plato's educational and epistemological program. His criticism is precise: to exclude poetic creativity from the search for knowledge of the truth. There is an abyss between philosophical rationality and poetic inspiration, and between them lies mathematical knowledge understood as a technique responsible for the transition between the *real and the ideal*, as well as other things. "Finally, the study of mathematics leads to the idea of unity and totality and allows us to know eternal and immutable beings such as the line, the circle, and geometric figures" (Paviani, 2008, p. 95).

By biasing the discussion of the *Ion* towards technical knowledge, Plato broadens its scope and compels us to look outside the text, since technique is a recurring theme in other dialogues. In this sense, the use of the lexicon serves to indicate the locus of the occurrences of technique and knowledge, as well as provide a brief interpretation of the situations in which they occur. As supporting literature, the lexicon points to transformations in concepts, a dialogical maturation - because Socrates' interlocutors in the dialogues have different cognitive qualities. Furthermore, "establishing the natural union of these works aims to show that they developed as increasingly complete expositions of Plato's ideas" (Schleiermacher, 2002, p. 41).

The most recent research in the area of the History of Mathematics has been organized around methodological sets originating from hybrid trends in Mathematics Education (Mendes, 2013). Interest in creativity is dealt with here from a historical-philosophical perspective. Historical because it provides society with a problematized interpretation of creativity in an ancient context. According to Barros (2017, p. 8), "the main job of historians is to construct interpretations that will give meaning to these facts". And philosophical because the discussion on creativity dealt with here is inserted in a philosophical research scenario, such as Plato's dialogues. "The Socratic method is therefore inseparable from thought in action. This is why we will find part of the philosophical foundations of this procedure within the text itself" (Folscheid & Wunenburger, 2006, p. 109).

The arguments found become auxiliary reflections for mathematics education or even questions that can serve as guidelines for further research, such as: "What does it mean to talk about creativity in this process of mathematical production over time? How can this affect educational activities today?" (Mendes, 2013, p. 186).

Euclid is credited with consolidating a *hypothetical-deductive* model for doing mathematics. A method that has become normative and represents the language of discovery for other mathematicians, from Archimedes to Galileo. The History of Mathematics, together with Philosophy, provides an access route for recognizing these same components in a period before Euclid, highlights their own emergence, and emphasizes what can be interpreted as creativity in this procedure.

Final considerations

Once the arguments have been developed and the methodological tools explained, it is time to review the points and connect them to form a network of meanings about creativity in Plato.

The concerns raised by the aforementioned authors in the *Introduction* prompted an analytical-critical reading of the *Ion*, in which passages were identified that consider creative activity to be a divine inspiration, a possession or a mania. The absence of a concept of *creativity* was then verified. Instead, we find the verb *poiéō*, which does indeed have the meaning of "to create", but is semantically linked to poetry. Some consequences emerge from this observation: the first is the very surprise of the absence of the concept, since "Socrates, Plato's teacher, is already considered the 'inventor' of the act of defining in the technical sense" (Schäfer, 2012, p. 73). To define "is to seek the essence of a concept" (Bicudo, 1998, p. 76): it is a matter of delimiting understanding as a systematic process of excluding contradictions, seeking "a common denominator", what Plato called "arriving at the essence/substance (*ousía*) of things". Socrates questions his interlocutors in the dialogues about what is beautiful, courageous, virtuous, etc., and in every case they provide examples, whether of a beautiful sculpture, a brave warrior or a virtuous act. Hence, the need for the dialectical method of investigation to go beyond common sense. If there were any suggestion of defining creativity in Plato's *corpus*, it would be attested to by tradition. Therefore, the absence of the concept translates into an absence of research.

The second consequence is based on the meaning of *poiéō* and the activity that comes from this verb. The discussion of creativity in Plato's philosophy is related to the action of poetry and has it as its guiding axis. Mathematics is mentioned in the *Ion* as a standard of comparison, a technical activity - among others - that serves as a parameter for determining what is and is not a technique. Among the techniques listed in this dialogue, arithmetic does not present a concrete product that can be immediately recognized through sensory perception, understood as "a physical-psychic apprehension, through a bodily organ" (Schäfer, 2012, p. 146), as is the case with the testimony of a patient's improvement, or an artifact made by a blacksmith, or a painting or sculpture. *Ion's* conclusion is that the poet and the rhapsodist do not engage in creative activity, since their product, poetry, results from a state of ecstasy. The connection between a creative agent and the result of his creativity is one of the foundations of modern research on creativity, as Leikin and Pitta-Pantazi (2012, p. 163) note: "It is generally believed that to detect creative behavior, it is necessary to detect the existence of a creative outcome. Research studies that focus on the creative product focus on ideas that are translated into tangible forms." In the absence of a concept of creativity, the product obtained by the creative action is its justification, which is available for other technicians to evaluate.

Both poetic and philosophical activity share a rapture, an overflowing of the self, that makes them possessed rather than possessors of the things they express. However, "the philosopher responds to the possessed and takes responsibility for them in a rational

relationship with them: he practices logon *didonai* in the mathematical exercise" (Schäfer, 2012, p. 256). According to the same author, logon *didonai* "means to provide a justification for a point of view or a statement" (p. 203) and is therefore "the necessary condition for the justification of all forms of knowledge". The ancient Greeks used mathematics as an argumentative paradigm for the justification of knowledge. In the modern context, "the elaboration of explanations and justifications" (Leikin & Pitta-Pantazi, 2012, p. 160) is part of cognitive approaches in creativity studies, albeit with an expanded scope.

With philosophy understood as the search for truth, Plato inverts the relative value of discourse. "Whereas Homer ascribes to the Muses the knowledge of a truth that can be revealed to and through an *aedo*, reserving falsehood to humans, Plato ascribes truth to human rational discourse" (Krausz, 2007, p. 176). Plato used reason and language as tools to cut through the inaccuracies and contradictions of discourse to arrive at authentic knowledge shared by all parties. It should be noted, therefore, that poetry and philosophy are juxtaposed against the background of a theory of knowledge and a plan of education.

The delimitation of the meanings of technique in Plato's philosophy shows that it expresses "skill in a profession", an "occupation", a "way of doing, mode", a "set of rules, system", a method (Bicudo, 1998, p. 75). Among the techniques, mathematics has a special place in Plato's metaphysical and pedagogical project, so knowing more about how he views it helps to transpose questions about poetic creativity to mathematical creativity. If, on the one hand, the absence of the concept of creativity in Plato's dialogues dissipates an objective presence, on the other hand, since these same dialogues are full of epistemological reflections, the subject comes up indirectly. That is, of course, as long as we take the attitude of not attributing to Plato what he didn't consider, but of questioning and interpreting his texts in the light of current theories of creativity.

This is what happens in the case of the *Mênon*, in which creative activity undergoes a *calculation of cause*. With creativity as the guiding agent of this work, we can't help but wonder how this calculation takes place. The properties of mathematical objects allow for connections that lead to the solution of a problem, and studies on creativity are interested in finding the best alternative that allows us to move from one argument to another. The task of epistemology is precisely to explain knowledge. The central problem of the *Mênon* is among the factors that influence creative development, as mentioned by Leikin and Pitta-Pantazi (2012, p. 161), namely teachability. Therefore, the same didactic concern that runs through the work of Gontijo et al. (2019) is present in Plato's philosophy. And again, instead of searching for a specific cognitive concept, Plato uses his cultural heritage and a paradigm shift in thinking to explain heuristic processes.

From the perspective of the four guidelines for research into creativity in mathematics education specified by Leikin and Pitta-Pantazi (2012, p. 163), the poet/rapper would not be a *creative person*, as he or she is not the driver of the *creative process*. It is a higher entity that is responsible for the *creative product*, which we later see confirmed in the *Timaeus*, accompanying the making of the cosmos by the demiurge. The change from one dialog to

another marks the shift from a negative connotation of creative activity to a positive one. The poet's creative product is verse that enchants and describes various technical activities, as we have seen, that of the soldier or general, the doctor, the blacksmith, and other characters who work in the field of the battles narrated. If asked about the production of medicines, weapons, etc., the poet and the rhapsode have nothing to say. And again because they don't possess the technique in question, they can't answer for their creativity. The agent who exercises creativity is the one who can account for his product, he is the one who can justify the processes that mobilized its manufacture, and even recognize those same processes - and whether they were well executed - in someone else's products.

On the other hand, the demiurge acts as a polytechnic, his divine status placing him in the position of holder of all knowledge and capable of justifying his production. When producing something, the demiurge knows the best form in advance, for the material to be used and the purpose for which his product will be destined. The *creative environment* is present in the context of the *Timaeus*, represented by chaos. The demiurge puts the disorderly in order, arranging the natural elements by applying organization, measurement and mathematical proportions.

Other questions could be raised by different interpretations. We hope that this work can stimulate reflections that can be converted into Mathematics Education.

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