

**The creation of an activity focused on teaching symmetry with the use of the generative artificial intelligence**

**La creación de una actividad enfocada en la enseñanza de la simetría con el uso de la inteligencia artificial generativa**

**La création d'une activité axée sur l'enseignement de la symétrie avec l'utilisation de l'intelligence artificielle générative**

**A criação de uma atividade voltada para o ensino de simetria com o uso da inteligência artificial generativa**

André Ricardo Antunes Ribeiro<sup>1</sup>  
Centro Universitário Internacional (UNINTER)  
Master in Science and Mathematics Teaching  
<https://orcid.org/0000-0002-1951-594X>

Evandro Alberto Zatti<sup>2</sup>  
Pontifícia Universidade Católica do Paraná (PUC-PR)  
PhD in Science and Mathematics Teaching  
<https://orcid.org/0000-0003-3123-1197>

Renata Oliveira Balbino<sup>3</sup>  
Secretaria de Estado da Educação (SEED-PR)  
PhD in Science and Mathematics Education  
<https://orcid.org/0000-0003-3402-3422>

Marco Aurélio Kalinke<sup>4</sup>  
Universidade Tecnológica Federal do Paraná (UTFPR)  
PhD in Mathematics Education  
<https://orcid.org/0000-0002-5484-1724>

**Resumo**

Este artigo apresenta uma investigação, de natureza qualitativa, com o desenvolvimento de uma atividade voltada para o ensino do objeto de conhecimento de simetria, com o auxílio da inteligência artificial generativa. O objetivo da pesquisa foi realizar uma análise sobre o potencial do uso simultâneo do Google Gemini e do Midjourney, utilizados como ferramentas de mediação dentro dos processos de ensino voltados para a área específica da Educação Matemática. Para tanto, desenvolvemos o roteiro da atividade no Gemini e posteriormente, no

---

<sup>1</sup> [aribeiro1075@gmail.com](mailto:aribeiro1075@gmail.com)

<sup>2</sup> [evandro.zatti@live.com](mailto:evandro.zatti@live.com)

<sup>3</sup> [renata.balbino@escola.pr.gov.br](mailto:renata.balbino@escola.pr.gov.br)

<sup>4</sup> [kalinke@utfpr.edu.br](mailto:kalinke@utfpr.edu.br)

Midjourney, criamos imagens com elementos geométricos de modo que os professores possam viabilizar discussões com estudantes acerca da temática direcionada para o Ensino Fundamental II, conforme indicação da Base Nacional Comum Curricular. Dentro da análise dos resultados, percebemos que a criação de um prompt estruturado é fundamental para a precisão dos resultados esperados, e que a análise crítica dos professores em torno dos resultados gerados também é essencial para a aplicabilidade juntos aos estudantes. Como conclusão, compreendemos que recursos da inteligência artificial generativa, que já são utilizados em outras áreas, são uma possibilidade de ferramenta de mediação para a Educação Matemática por meio da representação gráfica de elementos com formato geométrico. Além de promover o ensino por meio de concepções artísticas, eles podem favorecer, entre outros fatores, o envolvimento e a construção de novos conhecimentos, além de abrir novas discussões com os estudantes.

**Palavras-chave:** Educação matemática, Google gemini, Inteligência Artificial generativa, Midjourney, Tecnologias Digitais.

### **Abstract**

This article presents a qualitative investigation involving the development of an activity aimed at teaching the concept of symmetry, with the assistance of generative artificial intelligence. The objective of the research was to analyze the potential of the simultaneous use of Google Gemini and Midjourney, utilized as mediation tools within the teaching processes focused on the specific area of Mathematics Education. To this end, we developed the activity script in Gemini and subsequently, in Midjourney, created images with geometric elements so that teachers can facilitate discussions with students on the theme directed towards Middle School, as indicated by the Common National Curriculum Base. Within the analysis of the results, we noticed that creating a structured prompt is fundamental for the accuracy of the expected results, and that the critical analysis by teachers regarding the generated results is also essential for applicability with students. As conclusion, we understand that generative artificial intelligence resources, which are already used in other areas, are a possibility of mediation tool for Mathematics Education through the graphical representation of elements with geometric format. Besides promoting teaching through artistic conceptions, they can foster, among other factors, engagement and the construction of new knowledge, as well as open new discussions with students.

**Keywords:** Mathematics education, Google gemini, Generative artificial intelligence, Midjourney, Digital technologies.

## Resumen

Este artículo presenta una investigación cualitativa que involucra el desarrollo de una actividad destinada a enseñar el concepto de simetría, con la asistencia de inteligencia artificial generativa. El objetivo de la investigación fue analizar el potencial del uso simultáneo de Google Gemini y Midjourney, utilizados como herramientas de mediación dentro de los procesos de enseñanza enfocados en el área específica de la Educación Matemática. Para ello, desarrollamos el guion de la actividad en Gemini y, posteriormente, en Midjourney, creamos imágenes con elementos geométricos para que los profesores puedan facilitar discusiones con los estudiantes sobre el tema dirigido a la Educación Secundaria, según lo indicado por la Base Nacional Común Curricular. En el análisis de los resultados, notamos que la creación de un prompt estructurado es fundamental para la precisión de los resultados esperados, y que el análisis crítico de los profesores respecto a los resultados generados también es esencial para la aplicabilidad con los estudiantes. Como conclusión, entendemos que los recursos de inteligencia artificial generativa, que ya se utilizan en otras áreas, son una posibilidad de herramienta de mediación para la Educación Matemática a través de la representación gráfica de elementos con formato geométrico. Además de promover la enseñanza a través de concepciones artísticas, pueden fomentar, entre otros factores, la participación y la construcción de nuevos conocimientos, así como abrir nuevas discusiones con los estudiantes.

**Palabras clave:** Educación matemática, Google gemini, Inteligencia artificial generativa, Midjourney, Tecnologías digitales.

## Résumé

Cet article présente une enquête qualitative impliquant le développement d'une activité visant à enseigner le concept de symétrie, avec l'assistance de l'intelligence artificielle générative. L'objectif de la recherche était d'analyser le potentiel de l'utilisation simultanée de Google Gemini et Midjourney, utilisés comme outils de médiation dans les processus d'enseignement axés sur le domaine spécifique de l'Éducation Mathématique. À cette fin, nous avons développé le script de l'activité dans Gemini et, par la suite, dans Midjourney, créé des images avec des éléments géométriques afin que les enseignants puissent faciliter des discussions avec les élèves sur le thème destiné à l'enseignement secondaire, comme indiqué par le Socle Commun de Connaissances, de Compétences et de Culture. Dans l'analyse des résultats, nous avons remarqué que la création d'une instruction structurée est fondamentale pour la précision des résultats attendus, et que l'analyse critique des enseignants concernant les résultats générés est

également essentielle pour l'applicabilité avec les élèves. En conclusion, nous comprenons que les ressources d'intelligence artificielle générative, déjà utilisées dans d'autres domaines, représentent une possibilité d'outil de médiation pour l'éducation mathématique à travers la représentation graphique d'éléments au format géométrique. En plus de promouvoir l'enseignement à travers des conceptions artistiques, elles peuvent favoriser, entre autres facteurs, l'engagement et la construction de nouvelles connaissances, ainsi qu'ouvrir de nouvelles discussions avec les élèves.

**Mots-clés** : Éducation mathématique, Google gemini, Intelligence artificielle générative, Midjourney, Technologies digitales.

## **The creation of an activity focused on teaching symmetry with the use of the generative artificial intelligence**

The use of Artificial Intelligence (AI) has aroused collective interest recently. Society has become more attentive to the potential of this technological resource, considering that some results are currently proving to be important and have an impact on various sectors, such as health (in the accuracy of diagnoses and in drug research), technology (autonomous vehicles and computer vision systems), finance (fraud detection), commerce (product recommendations and automation in customer service), among many other possible examples. In terms of educational processes, especially in mathematics education, AI can also have an impact that needs to be analyzed and evaluated.

There has been great progress in AI in its various fields and specificities, as in the case of Machine Learning (ML), which works with algorithms that allow a program to "learn". In these cases, programmers do not need to determine a code that specifies the actions or predictions that the program should take in a given situation (Gabriel, 2022). "In ML, the algorithm is usually different from a traditional one. The reason is that the first step is to process data so that the computer can then start learning. Therefore, learning is undoubtedly the key to AI" (Santaella, 2023, p. 130).

Zatti and Kalinke (2021, p. 78) argue that "in machine learning, algorithms analyze data to identify patterns and build a model to predict future values. The authors also add that the branch of AI that explores research with artificial neural networks (ANN) and ML is called connectionist (Zatti; Kalinke, 2021).

Vicari (2021) considers that the greatest current advances in AI have been made through machine learning, through extensive training on large datasets, using knowledge representation mechanisms and reasoning processes based on both ANNs and statistical models, whether hybrid or not.

Because of advances in ML, another area of AI that has gained significant importance is Deep Learning (DL). DL has promoted the improvement of various available resources, such as chatbots or conversational agents, the most famous examples of which are the ChatGPT<sup>5</sup> and Google Gemini<sup>6</sup> platforms, which use natural language processing (NLP) mechanisms. We should also mention facial recognition systems, which are used, among other things, as a form of user authentication in data validation processes. These systems are used on e-commerce sites,

---

<sup>5</sup> <https://chat.openai.com/>

<sup>6</sup> <https://gemini.google.com/app>

by government agencies, and by educational institutions, for example, to verify student attendance.

Regarding the dimensions of ML and DL, and consequently, their relationship, they can be illustrated in Figure 1, based on the representative model of AI, or how it's "thinking" model works in line with Big Data<sup>7</sup>, according to the precepts of Data Science.

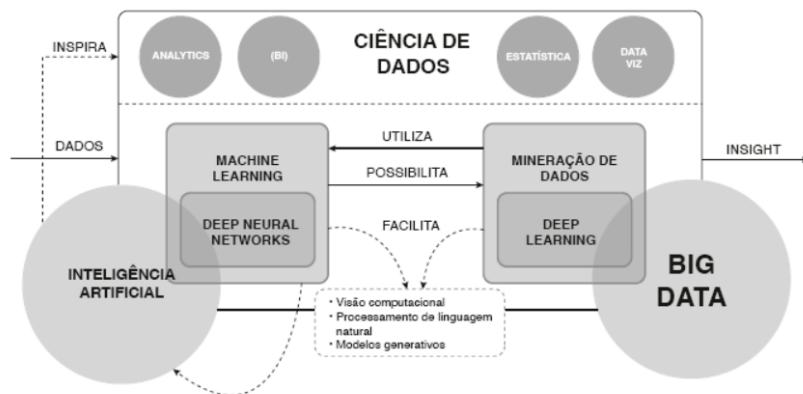


Figure 1.

*AI's "Thinking" System (Gabriel, 2022, p. 71).*

Figure 1 shows that data science is a field that supports fields such as AI and its subfields such as ML, which includes deep neural networks. In this way, there is an interaction with a continuous movement of data input and output associated with Big Data and its subfield represented by Data Mining, which directly involves DL. Because of this process, generative models (such as computer vision and natural language processing) are the result of interactions between DL and ML.

One of the applications of these systems is Generative Artificial Intelligence (GAI), which is a resource that has been applied in different sectors and for different purposes, such as legal advice, in the case of specific laws; health, in the case of diagnoses, in the translation of texts and in the organization of content, among others. According to McIntosh et al. (2023, p. 1), "the development of artificial intelligence took a decisive leap forward with the emergence of large language models (LLMs), such as ChatGPT, developed by OpenAI, and the recent launch of Gemini by Google". Generally speaking, an IAG is a tool that can contribute to

<sup>7</sup> According to Amaral (2016), "Big Data is considered a phenomenon in which data is generated in various formats and has the capacity to be stored by an immense amount of equipment and devices. Technological innovations through the miniaturization of devices and components such as processors are becoming increasingly sophisticated, providing more operational capacity to handle an ever-increasing amount of data".

various tasks, such as formatting paragraphs, bullets and tables, creating poems, texts and scripts, optimizing routine tasks that are part of the context of different professionals in different sectors (Birss, 2024).

According to HubSpot & Jasper (2023), IAG is a form of AI that has the ability to assimilate human information and design something completely original, be it art, text, video, or audio. It is capable of generating a new work from an initial stimulus. This type of AI evolves by absorbing natural language learning models and consuming content. Added to this scenario are generative adversarial networks (GAN), which are deep learning architectures. They aim to train two ANNs to "compete" with each other, intending to generate new, more authentic data from a given set of training data.

According to Espírito Santo et al. (2023), GANs are a type of RNA that can generate realistic images of faces and landscapes, as well as unique texts such as news articles, posts, and short stories. The possibilities for creating with GANs are vast, allowing for the creation of entirely new textual, visual, and audio content.

An IAG is a broad concept driven by a GAN, which is "actually a pair of networks that combine to form a generative system" (Russell; Norvig, 2022, p. 705). According to these authors, its operation is based on two networks: a discriminator and a generator. "Both the generator and the discriminator are trained simultaneously, with the generator learning to fool the discriminator and the discriminator learning to accurately separate real from false data" (Russell; Norvig, 2022, p. 705).

To find more examples, we took the initiative to carry out a brief survey of scientific productions related to the use of IAG in education. Although it is not the purpose of this research to carry out a systematic mapping (SM), we have followed the considerations of Motta (2021), who defines some stages for the development of this model and other bibliographic surveys.

Among these steps, we highlight the definition of a database, in which "the researcher must determine where he wants to search, that is, and he must define the database for the extraction of works that have an affinity to be studied in the SM" (Motta, 2021, p. 32). Another important step in this process is the definition of descriptors and strings: "Once the databases have been defined, it is essential that the researcher defines the descriptors, i.e., the search terms that will be used to identify the works" (Motta, 2021, p. 34). Following these rules, we consulted the following databases: the Digital Library of Theses and Dissertations (Biblioteca Digital de Teses e Dissertações - BDTD) and the CAPES Catalog of Theses and Dissertations. When defining descriptors and strings, we used the following combination: "generative artificial intelligence AND mathematics education".

The search in the BDTD yielded one (1) dissertation that correlates AI with mathematics education, but does not relate to the use of IAG in mathematics teaching and learning processes. In the catalog of theses and dissertations, two (2) master's theses were found that include the use of IAG in mathematics education, but using resources exclusively for an LLM, which is different from the combined use of an LLM with a GAN, as proposed in this research.

Despite the relative scarcity of research on the subject, it should be recognized that, in addition to the selected databases, there is currently a gradual movement of research on the applicability of IAG resources in pedagogical processes involving mathematics education.

One of these studies suggests some possibilities, such as the use of virtual tutors through chatbots; or even the use of IAG to create personalized educational resources, such as didactic sequences or lesson plans (Aguirre, 2024).

To contribute to the discussion on the incorporation of these technological resources in educational processes, this research aims to investigate aspects of the integration between IAG and pedagogical practices aimed at teaching symmetry, by trying to answer the following guiding question How can IAG environments be used to create an activity on the content of symmetry?

### **Digital Technologies, AI, and Mathematics Education**

The convergence of digital technologies (DTs), AI, and mathematics education has triggered changes that have the potential to affect educational processes. As technological resources have become ubiquitous, the possibilities for their use in the classroom have increased (Kalinke et al., 2017). With the advancement of AI, DTs have evolved to the point of becoming cognitive partners capable of providing personalized feedback, tailoring instruction to students' individual needs, and even predicting potential errors. These capabilities not only change the way students interact with mathematical concepts, but also challenge professors to rethink their pedagogical practices. As Russell and Norvig (2022, p. 19) point out

AI covers a giant variety of subfields, from the general (learning and perception) to specific tasks, such as playing chess, demonstrating mathematical theorems, creating poetry, driving a car on a busy road and diagnosing diseases. AI is relevant to any intellectual task; it is truly a universal field (Russell; Norvig, 2022, p. 19).

This combination of tasks inherent to cognitive activities reinforces the viability of their use in different fields. Considering that there is a direct relationship between DM, AI and Mathematics Education, as proposed by Mattos (2022), given the possibility of using images



created by IAG in Mathematics educational activities, it is possible to deepen the relationship between this discipline and the Arts.

According to Hildebrand and Valente (2023), Art, Mathematics and the media share syntactic, semantic and linguistic principles that are interconnected with all forms of knowledge making throughout history. A fundamental similarity between them is that they are structured through languages, which in turn use signs to represent elements of nature and culture. Both the arts and mathematics depend on means to structure themselves.

This is a significantly old relationship, which has crossed several phases of human existence, and which can be exemplified when

[...] Renaissance artists represented the world on their canvases using rules of mathematical proportion originating from the Pythagoreans and Polyklethus in Ancient Greece. They were rules of Euclidean geometry that were too simple. Representing man and the surrounding space scientifically was a goal of art and, why not say it, of mathematics and geometry in the pre-industrial period (Hildebrand & Valente, 2023, p. 81).

This connection between man and art and mathematics has lasted for centuries, maintaining a tradition of faithful representation of reality. With TD and the use of specialized computer graphics software and tools, artistic representations can be simulated using computers. They can now be used for specific purposes, such as education. For example: representations of geometric objects in the teaching of mathematics; of living beings in the teaching of biology; of celestial bodies in astronomy, etc.

Among the tools that can be used to create images in educational processes is Midjourney<sup>8</sup>, which can be used to create high-quality images from relatively simple texts. In this environment, you can type a text describing an image you want to create using IAG resources, and the result is displayed in a few seconds. It runs directly in the browser, so no special hardware or software is required.

Environments such as Midjourney, as image-generating tools, can become collaborative tools in simulation and immersion processes, including educational activities. In this sense, Lévy (1999) believes that:

As for the image, it loses its spectacle exteriority to open up to immersion. Representation is replaced by the interactive virtualization of a model; simulation replaces likeness. The drawing, the photograph, or the film gains depth and welcomes

---

<sup>8</sup> <https://www.midjourney.co/pt>

the active explorer of a digital model, or even a work or play group involved in the cooperative construction of a universe of data (Lévy, 1999, p. 150).

Considering the importance of immersion in this process, for the author, simulation can also contribute to the acquisition of knowledge, since:

[...] simulation is now playing a growing role in scientific research, industrial design, management and learning, but also in games and entertainment (especially interactive games on the screen). Neither theory nor experience, a form of industrialization of the experience of thinking, simulation is a special mode of knowledge, specific to the emerging cyberculture (Lévy, 1999, p. 166).

In addition, the simulation represented by images favors the understanding of concepts based on the realism of a given situation, in which our perception of how close it is to reality is made possible by the visualization itself.

Also in this context, Flores (2016) considers that images are conceived as spaces for the exercise of thought, and a mathematical perspective, for example, is the result of these visual practices, and mathematical knowledge is a way of expressing truths about how we represent and observe. This is due to the understanding that visual practices shape not only the subject who observes, but also the object observed, both visible and invisible things.

These aspects can be explored when working with symmetry in elementary education. By working with this theme, students have the opportunity to develop observational skills and to notice differences and similarities between figures. The Common National Curriculum Base (BNCC), which mentions the term "symmetry" seven times, states that

It is also important to consider the functional aspect that must be present in the study of geometry: geometric transformations, especially symmetries. The fundamental mathematical ideas associated with this subject are mainly construction, representation, and interdependence (Brasil, 2018, p. 271).

Thus, by addressing the ideas of bilateral symmetry (or reflection), radial symmetry (or translation), and rotational symmetry (or rotation), their understanding can help develop spatial skills and the perception of position, characteristics, and image shape. By using AI resources in this approach, we can add knowledge about how IAG environments work and discuss it with students, contributing to any future uses they may make.

### **Methodological aspects**

To answer this question, we decided to carry out a qualitative study whose approach can be identified as a case study. The justification for this research is based on contributions related to the study of DM and its mediation tools, aimed at the construction of mathematical knowledge. In this sense, the Research Group on Technologies in Mathematics Education (GPTEM)<sup>9</sup> has dedicated itself to the search for understandings about the use of DM in mathematics education, in a collaborative way among its members.

We consider this research qualitative in nature, as it is a study within a specific context, i.e., the educational sphere. It considers the interactions involved, which involve an interpretive and flexible approach for the researchers.

Qualitative research is a research methodology that seeks to understand certain phenomena, considering the social and cultural contexts in which they are embedded. According to Borba (2004), qualitative research is characterized by valuing human interactions and narratives, which is particularly relevant for studies focused on the educational context.

According to this author,

What has come to be called qualitative research privileges descriptive procedures to the extent that its conception of knowledge explicitly allows for subjective interference, knowledge as understanding that is always contingent, negotiated, and not rigid truth. What is considered "true" within this conception is always dynamic and subject to change. This does not mean that quantitative data or even research based on a different conception of development should be ignored (Borba, 2004, p. 2).

This type of research makes it possible to study teaching practices, the perceptions of those involved in educational processes, and the dynamics of the school environment. This methodology involves an interpretive stance for the researchers. The results do not seek generalizations, but rather a detailed and contextualized understanding of the object of study, enabling the search for understandings that can influence different teaching practices, as in this research.

The case study is a predominantly qualitative approach, which is a method of studying a social phenomenon used in research focused on educational processes. The choice of this methodological approach is related to the nature of this research, which sought to analyze the potential simultaneous use of Google Gemini and Midjourney as mediation tools in mathematics teaching processes. According to Marconi and Lakatos (2022, p. 306), "the case

---

<sup>9</sup> <https://gptem5.wixsite.com/gptem>.

study refers to an in-depth study of a particular case or human group from all aspects [...] its aim is to grasp a given situation and describe the complexity of a fact".

Some research carried out by GPTEM members has brought investigative contributions to AI in the field of mathematics education. Among these are analyses of AI from theoretical and philosophical perspectives (Silva, 2023); investigations into ergonomics and interaction design for AI-based interfaces (Balbino, 2023); insights into AI and intuitive programming (Mattos, 2022); and the design of an AI-based platform for creating learning objects (Zatti, 2023), among others in progress. Given the recent technological advances, including AI, and their impact on various sectors of our society, such as education, it is necessary to continue a movement of investigation since the use of DT in education can change the way mathematics is learned (Papert, 1986).

In the search for data for analysis, two IAG platforms were used to create an activity aimed at teaching symmetries: one called text-text (textual prompt and textual result), which helps organize an activity on the content, and another called text-image (textual prompt and graphic result), which helps build images related to the same content.

To design the prompts, we followed the C.R.E.A.T.E. structure recommended by Birss (2024), which deals with prompt generation and is described in Table 1.

Table 1.

*Structure of prompt creation C. R. E. A. T. E. (Birss, 2024)*

<b>Topic (Translation)</b>	<b>Features</b>
<b>Character</b>	Function of creating responsibility for the chatbot. For example, <i>make it identify itself as a chef, a celebrity, a renowned scientist, a writer, etc.</i>
<b>Request</b>	<i>Create a request for the chatbot to work for you. Ideally, you should provide examples that are close to the expected result. Ex: "I want you to create an incredible recipe using only the ingredients I have in the fridge. Start by asking me what ingredients I have available".</i>
<b>Examples</b>	Information that can be invaluable in the search for answers. E.g., : <i>"Take inspiration from chefs such as Gordon Ramsay, Marc Pierre White, and Erick Jacquin"</i>
<b>Additions</b>	At this stage, extra data can be entered to improve the answers, since a first result may not be convincing. For example: <i>"List the measurements in imperial units. Don't use all the ingredients: use only what is necessary for the dish. Don't suggest a recipe until I give you my ingredients."</i>
<b>Type of Output</b>	Explain your formatting preferences to the chatbot. It can provide answers using bullet points, tables, poems, scripts, etc. The important thing is to express yourself clearly. E.g., <i>"Write your answer like a recipe. Give me a recipe title, a 100-word paragraph describing the dish, a list of ingredients, and simple steps to follow. Write in your preferred language, simplified, without jargon."</i>
<b>Extras</b>	Look for approaches that aren't obvious and typical; explain your thinking. E.g., : <i>ask the chatbot to deconstruct a joke. Suggest that the chatbot asks you a question before providing the answer. Encourage the conversation to continue.</i>

As for the methodological procedures, we adopted the following steps: 1) identifying the skills and competences in the BNCC document (to check the level of education at which the activity would be aimed); 2) selecting the textual and graphical platforms for the IAG; 3) creating the activity; 4) generating the images; 5) analyzing the results.

In step 1, consulting the BNCC, we identified that skill EF07MA21 consists of "recognizing and constructing figures obtained by translation, rotation and reflection symmetries, using drawing instruments or dynamic geometry software, and linking this study to flat representations of works of art, architectural elements, among others" (Brazil, 2018, p.

309). This skill is explored in the 7th grade math class, in the knowledge object of symmetries, from the Geometry thematic unit.

In stage 2, we chose Gemini as the textual IAG platform to create the activity script. It was chosen because it can be used with a simple login process to a Google account and is currently an alternative to the well-known platform created by the OpenAI Company, ChatGPT, and the like.

As an IAG platform for image generation, we decided to use the paid version of Midjourney. This was because free platforms don't offer the realism and quality of graphical results similar to those obtained with Midjourney. We recognize that this option is not ideal, but it is justified as a chance of use from which it will be possible to evaluate possible results that can be compared in the future with those offered by free environments that are gradually improving the resources offered to users.

In step 3, we used the recommendations of Birss (2024) as a basis for creating the text prompt, following the C.R.E.A.T.E. structure for creating these commands. In step 4, which consists of generating the prompts in Midjourney, we tried to edit the examples provided within the platform itself, considering that there is a bank of prompts available with results published by different users with different graphic conceptions: abstract, futuristic, artistic, children's drawings, anime, etc. The modification and improvement of the available prompts is necessary due to the copyright of the users of the platform.

In step 5, we try to analyze the experiment, with the corresponding reflections on the results obtained.

### **The creation of the activity at Gemini**

After completing steps 1 and 2, respectively, defining the educational level in which the activity was aimed at 7th grade students according to the BNCC document (step 1) and selecting the textual and graphical IAG platforms (step 2), we proceeded to present the simulated activity with the prompt used.

For the activity, we created the following prompt, which we used in Gemini (Figure 2).

**"You are an expert in mathematics, recognized worldwide and winner of the Fields Medal winner. Create an activity that involves teaching geometry using Midjourney to generate geometric images. Consider as a learning objective 'Recognize and classify different types of symmetry in geometric figures'. Geometric figures'. Write your answer in the form of just one table containing all the steps.**

Figure 2.

*Prompt for building the activity in Gemini*

We indicated to *Gemini's* AI to respond as “a math expert, recognized worldwide, and winner of the *Fields Medal*”, creating a responsibility and fulfilling the *character* item of the C.R.E.A.T.E. *prompt* creation developed by Birss (2024). Only then did we make the *request*, considering the learning objective of teaching geometry to students at the level in question.

Finally, we asked for the answer to be formatted in just one table, meeting the type of *output* criteria. We chose this specification because, on a first attempt, the *chatbot* offered a table for each different stage.

The use of the *Gemini* environment resulted in Table 2 below, in which IAG suggested segmentation into four stages, made up respectively of Activity, in which actions are suggested to be presented to the students, *Prompt* to be used in Midjourney to create the images, Analysis, in which suggestions are made on how to approach the content with the students and, finally, tips for constructing the *prompt*.

Table 2.

*Results generated in Gemini*

Stage	Activity	Midjourney's Prompt	Analysis	Tips for Building the Prompt
<b>1. Unraveling Bilateral Symmetry</b>	Find a butterfly with bright, trapezoidal wings. Notice how the wings divide into two identical parts if you imagine a vertical line down the middle.	A majestic butterfly with trapezoidal wings, vibrant colors and bilateral symmetry. The vertical line of symmetry divides the wings into two mirrored parts.	Identify the bilateral symmetry of the butterfly's wings, with a vertical axis of symmetry dividing the figure into two congruent parts. Explore how this symmetry contributes to the butterfly's beauty and precise flight.	<ul style="list-style-type: none"> <li>* Focus on Symmetry: Specify bilateral symmetry and include details that demonstrate it in the description of the butterfly.</li> <li>* Descriptive Details: Use vivid language to describe the butterfly's of the butterfly, incorporating elements that highlight its symmetry.</li> </ul>
<b>2. Exploring Radial Symmetry</b>	Observe an owl with piercing circular eyes. Notice how the circular shape of the eyes is repeated in different parts of the owl's body.	Owl with circular eyes, with vivid colors and radial symmetry. The circular shape of the eyes is repeated in different parts of the owl's body.	Identify the radial symmetry of the owl's eyes, with multiple axes of symmetry passing through the center of the figure. Explore how this symmetry gives the owl a wide and precise field of vision.	<ul style="list-style-type: none"> <li>* Focus on Symmetry: Specify radial symmetry and include details that demonstrate it in the owl's description.</li> <li>* Descriptive Details: Use vivid language to describe the owl's appearance, incorporating elements that highlight its symmetry.</li> </ul>

<b>3. Discovering Rotational Symmetry</b>	Find a snowflake with six identical sides. Imagine how it rotates around its center while maintaining its original shape.	Hexagonal snowflake with six identical sides and rotational symmetry. The snowflake can rotate around its center without losing its shape.	Identify the rotational symmetry of the snowflake, which has multiple axes of symmetry that allow it to rotate without changing its shape. Explore how this symmetry contributes to the beauty and complexity of snowflakes.	* Focus on Symmetry: Specify rotational symmetry and include details that demonstrate it in the description of the snowflake. * Descriptive Details: Use vivid language to describe the snowflake's appearance, incorporating elements that highlight its symmetry.
<b>4. Creating Symmetrical Figures and Objects with Midjourney</b>	Choose an object or geometric shape and imagine what it would look like if it had bilateral, radial or rotational symmetry. Create a prompt in Midjourney to bring your symmetrical creation to life.	Use your creativity to create a prompt that represents the type of symmetry you have chosen.	* Creativity: Use your imagination to create a unique and interesting object or shape that represents the type of symmetry you have chosen.	

Looking at Table 2, we can see that Gemini not only offers a total of four steps to achieve the proposed learning objective, but also provides suggestions for constructing the prompt used in Midjourney, as well as tips that can be useful in the analysis that professors should conduct with students during and after the activity. The Stage column identifies bilateral symmetry, radial symmetry, and rotational symmetry. The Analysis column provides suggestions on what aspects of symmetry professors can work on.

### Step 3: Creating the images in Midjourney

At this stage, we used the results offered by Gemini, presented in the "MidjourneyPrompt" and "Tips for building the prompt" columns, to generate the images. Taking advantage of the possibility to insert parameters, we used them ad hoc so that the creations presented different conceptions. It's important to note that the platform generates a total of four image variations by default.

**For Stage 1: Reveal bilateral symmetry**, the suggested prompt was: "Majestic butterfly with trapezoidal wings, vibrant colors, and bilateral symmetry. The vertical line of symmetry divides the wings into two mirrored parts". We translated it into the English language used on the platform and added both the image description and the parameters, arriving at the following prompt: "Majestic butterfly with trapezoidal wings, with vibrant colors and bilateral symmetry. The vertical line of symmetry divides the wings into two mirrored parts: Disney style, chibi, full body, cute, unreal engine, ultra-detailed, 8k, --ar 16:9 --style raw --v 6.0".



Regarding the terms used in the description, Disney style was used to customize the image according to the character models created by the famous American studio; chibi is a characteristic term for anime or manga drawings, of Japanese origin; cute is an English term whose translation can be understood as graceful; unreal engine is a 3D rendering platform specifically designed for the development of high-resolution digital games; 8k is a term used to describe ultra-high-definition images (Ultra HD, which has 7680 x 4320 pixels). Other complementary terms, such as whole body and ultra-detailed, have been used to enhance the realism of the images.

Regarding the parameters used, "ar" (aspect ratio) "changes the aspect ratio of the generated image. An aspect ratio is the ratio of the width to the height of an image. It is usually expressed as two numbers separated by a colon, such as 7:4 or 4:3" (Midjourney, 2024). We use 16:9 dimensions because this is the ratio commonly used for desktop displays or media such as television. The style raw parameter indicates that the images "have less automatic embellishment applied, which can result in a more accurate match when specific styles are requested" (Midjourney, 2024). Finally, "v 6.0" is the current version of the platform. Figure 3 illustrates these results.



Figure 3.

*Stage 1 results*

By analyzing the four proposed images, it is possible to see that they can be effectively used to work with the content of symmetry, as they allow working with bilateral symmetry, or reflection symmetry, when a vertical axis is drawn in the center of the butterfly's body.

**In Step 2: Exploring Radial Symmetry**, the prompt generated was: "Owl with circular eyes, with bright colors and radial symmetry. The circular shape of the eyes is repeated in different parts of the owl's body. hyperrealistic<sup>10</sup>. natural light. hd. 50 mm --air 1:1 -v 6.0".

In this case, we added the following adjectives to the description: hyperrealistic; natural light; hd (high definition); 50 mm for the lens used in photo cameras, and as parameters the ratio "air 1:1" and version 6.0. Figure 4 shows the results.



Figure 4.

*Stage 2 results*

With the results presented, it is possible to work with the four images suggested for working with radial symmetry, for example, by moving the eyes from left to right in any of the owl images used.

---

<sup>10</sup> Owl with circular eyes, vivid colors and radial symmetry. The circular shape of the eyes is repeated in different parts of the owl's body. hyper realistic. natural light. hd. 50mm --air 1:1 -v 6.0.

To finish generating images, in **Step 3: Discovering Rotational Symmetry**, the prompt presented was: "A hexagonal snowflake with six identical sides and rotational symmetry<sup>11</sup>. provia film style. dark white and sky blue. high detail. cinematographic view. 8k. --ar 7:4 --s 80 --v 6.0".

This description refers to the style of Provia film, a specific line of photographic film produced by the Japanese company Fuji Film, characterized by its vivid colors. The dark white sky blue was an option to create contrast between dark and light colors in a blue tone, influenced by the colors of the stratosphere. The terms high detail, cinematographic view, and "8k" correspond to a demand for high-resolution and high image quality. As for the proportions, the aspect ratio parameter (ar 7:4) has been provided to emphasize the width of the image. As for the stylize parameter, "The Midjourney bot has been trained to produce images that favor artistic colors, compositions, and shapes. The stylize parameter influences how much of this training is applied" (Midjourney, 2024). The result is the images shown in Figure 5.

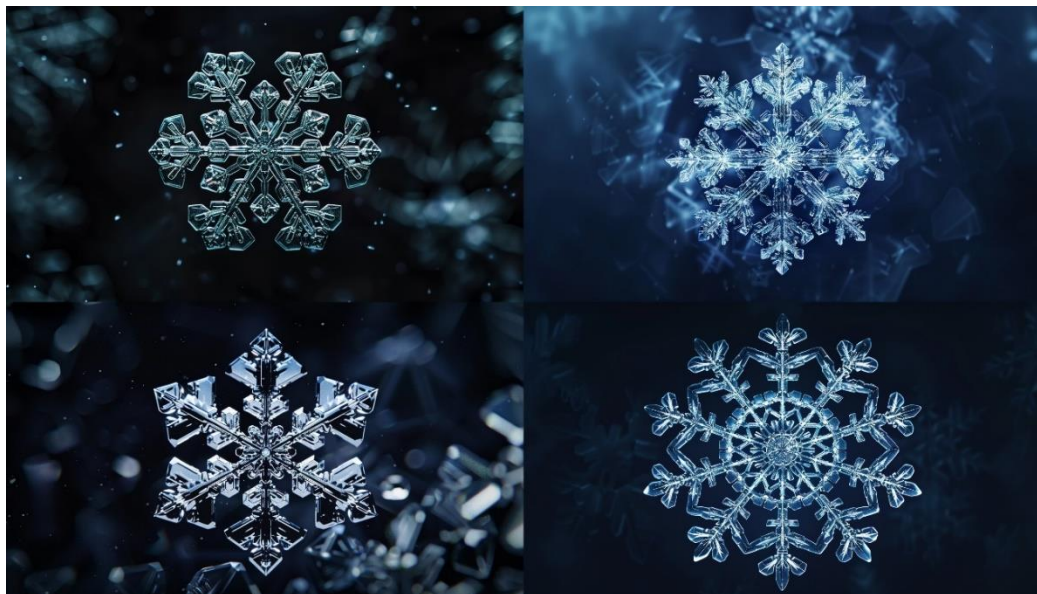


Figure 5.

*Results of Stage 3*

---

<sup>11</sup> *Hexagonal snowflake with six identical sides and rotational symmetry. The snowflake can rotate around its center without losing its shape.*

By analyzing the four proposed images, we can see that they allow us to work with rotational symmetry, or rotation, if we select one of the images and propose to rotate it around the central point.

With the data presented, in the next section we will present an analysis of the results obtained.

### **Analysis of results**

It can be said that the construction of the activity aimed at teaching symmetry, using the Gemini LLM platforms with the GAN Midjourney platform, met the specific needs of the activity. Since IAG is a resource that depends on the creativity of the user, there are numerous possibilities for using this type of resource to create teaching activities in a textual format.

In the case of Gemini, the result presented in the form of a table accurately described the model of an activity and indicated how the analysis could be carried out by the professor with the students. There could be other ways to evaluate the integration of IAG with the teaching of geometry, depending on the expectations of the students' knowledge building process and the class they intend to work with, among other characteristics that should be evaluated by the professor in charge of the activity.

In the case of Midjourney, both the task of creating and analyzing the images makes the artistic moment enjoyable and stimulates, among other things, the creativity and curiosity of the participants. For Flores (2016), images function as places where different ways of thinking are applied and visualizations are explored. This represents a possible relationship between DT, AI, and mathematics education, also considering art. The images generated by the environment meet expectations and can be used to work with symmetries, whether bilateral, radial, or rotational. As they are AI-generated images, they can also be used to discuss how this technology is used in the daily life of the students in different applications that they use almost every day on their smartphones, to listen to music, do research, and explore games, among others.

Art is considered a space for analyzing visual practices, outlining thinking techniques and strategies, and influencing ways of observing and representing, while mathematics is both the result of a visual perspective and an agent in shaping ways of thinking. This context can be

an environment for practicing and developing mathematical thinking in a creative, inventive, and sensitive process (Flores, 2016).

It is worth noting that although in this experiment we used Midjourney, which is a paid platform, this activity model can also be carried out on other free platforms such as Stable Diffusion, Limewire and Adobe Firefly, although this requires new knowledge and more specific attempts.

### **Considerations**

The use of LLMs such as Gemini or ChatGPT has become widespread in academic environments, both because they are intended to be used as support tools for routine activities such as research, translation, creating summaries, replying to emails, and tables, among other resources, which have often produced surprising results. However, these resources have also been used to commit illegal acts, such as plagiarism and the creation of so-called fake news. The use of these resources in educational activities can bring these discussions into the school environment and broaden the understanding of the use of AI in both educational and everyday applications.

The use of GANs such as Midjourney is particularly promising in fields that rely heavily on the mass and commercial production of graphical resources, such as advertising, design, and architecture. However, its use is not limited to these areas alone, and can be explored in educational fields such as history (graphical representation of specific periods and events), geology (graphical representation of types of terrain), biology (external and internal representation of vertebrates and invertebrates), astronomy (graphical representation of celestial bodies), and medicine (graphical representation of human body organs). In this research, we present a possibility of using these resources in mathematics education through the graphical representation of geometrically shaped elements.

In the specific case of IAGs for creating images, you could extend the discussion with students by raising ethical or worrying aspects, such as the fact that they can be used to create deep fakes or lying graphic montages that are intended to harm other people. We can also talk about "hallucination", which is the term used when IAGs produce impossible, unrealistic

results. This is a false result, but one that is not malicious for the user, but one that is produced by the AI itself.

This research has shown that the use of the Gemini and Midjourney platforms can contribute to the teaching of symmetry as an alternative to learning abstract concepts that require mechanical memorization. The use of prompting techniques, such as the C.R.E.A.T.E. methodology, allows students to visualize geometric shapes and their properties in an assertive way. It also allows them to respond to their individual learning styles and needs. However, we recognized that the prompts used in particular required specific technical knowledge that was not part of the professors' daily routine. Using parameters like "8k. --ar 7:4 --s 80 --v 6.0", which are present in Step 2 for illustration, require technical knowledge that is different from that traditionally mastered by professors. Thus, mastery of technical aspects will be necessary for users involved in activities such as those proposed here, and may be an obstacle for those who do not master them. However, the intention of the research is to show possibilities, and in this sense, we believe that it has achieved what it set out to do.

In a complementary way, the exploration of different teaching strategies can promote creativity and conceptual understanding in the teaching of symmetry, as well as the incorporation of interdisciplinary knowledge, such as AI concepts (in the creation of prompts and the use of parameters).

Although we consider experiments of this kind to be valid, it is worth pointing out that attempts of this nature reinforce the role of the professor as a protagonist, associating the incorporation of technological tools with a mediating potential in pedagogical practices. The professor remains fundamental, from the conception of the activity, through the creation of prompts, to the final analysis with the students. Nevertheless, the integration of DT in the classroom can help to promote creativity, conceptual understanding and knowledge construction in various fields.

We hope that this research will encourage other professors to explore teaching practices that relate visual concepts to mathematics through the use of DT, creating viable alternatives for pedagogical transformation that stimulate the construction and relationship of mathematical knowledge with different areas of study.

## Acknowledgements

We gratefully acknowledge the support of the National Council for Scientific and Technological Development (CNPq), granted through CNPq/MCTI call No. 10/2023, project 402192/2023-0.

## References

- Aguirre, U. J. C. (2024). Possibilidades entre a Educação Matemática e Inteligência Artificial Generativa (IAG) em sala de aula. *Seminário Internacional De Pesquisa Em Educação Matemática* (pp. 1-12). <https://www.sbembrasil.org.br/eventos/index.php/sipem/article/view/453>
- Amaral, F. (2016). *Introdução à Ciência de Dados: mineração de dados e Big Data*. Alta Books.
- Birss, D. (2024). *The Prompt Collection*. [LinkedIn Learning]. <https://www.linkedin.com/learning/how-to-research-and-write-using-generative-ai-tools/meet-your-ai-creative-collaborator>.
- Balbino, R. O. (2023). *Uma proposta para concepção de interfaces para plataformas educacionais de matemática assistidas por inteligência artificial*. [Tese de Doutorado em Educação em Ciências e em Matemática, Universidade Federal do Paraná]. <https://hdl.handle.net/1884/86923>.
- Borba, M. C. A. (2004). *Pesquisa Qualitativa em Educação Matemática*. [https://www.researchgate.net/publication/228889292\\_a\\_pesquisa\\_qualitativa\\_em\\_educacao\\_matematica](https://www.researchgate.net/publication/228889292_a_pesquisa_qualitativa_em_educacao_matematica).
- Brasil. (2014). Brasileiro conquista prêmio tão importante quanto o Nobel. Ministério da Educação. <http://portal.mec.gov.br/ultimas-noticias/222-537011943/20672-brasileiro-conquista-premio-tao-importante-quanto-o-nobel>.
- Brasil. (2018). Base Nacional Comum Curricular. Ministério da Educação. [http://basenacionalcomum.mec.gov.br/images/BNCC\\_EI\\_EF\\_110518\\_-versaofinal\\_site.pdf](http://basenacionalcomum.mec.gov.br/images/BNCC_EI_EF_110518_-versaofinal_site.pdf).
- Espírito Santo, E. do; Rosa, F. G. M. G.; Silva, C. B. da; Bordas, M. A. G. (2023). Um mosaico de ideias sobre a inteligência artificial generativa no contexto da educação. In: Alves, L. (Org.). *Inteligência artificial e educação: refletindo sobre os desafios contemporâneos* (pp. 51-69). UEFS Editora.
- Flores, C. R. (2016). Descaminhos: potencialidades da arte com a educação matemática. *Bolema*, 30(55), (pp. 502-514). <https://www.periodicos.rc.biblioteca.unesp.br/index.php/bolema/article/view/9432>. <http://dx.doi.org/10.1590/1980-4415v30n55a10>
- Gabriel, M. (2022). *Inteligência Artificial: do zero ao metaverso*. Atlas.
- Google Deepmind. (2023). *Welcome to the Gemini era*. <https://deepmind.google/technologies/gemini/#introduction>.
- Hildebrand, H. R.; Valente, J. A. (2023). *Artes, Matemática, Pensamento Computacional e as Mídias*. Editora Unicamp.

- Hubspot & Jasper. (2023). *Utilização de IA generativa para expandir as operações de conteúdo* [E-book]. <https://br.hubspot.com/ofertas/generative-ai>
- Kalinke, M. A.; Mocrosky, L. F.; Panossian, M. L.; Banin, E. S. (2017). Tecnologias digitais na formação e prática dos futuros professores de Matemática. *Revista Brasileira de Ensino de Ciência e Tecnologia*, 10(2), 360-378. <https://periodicos.utfpr.edu.br/rbect/article/view/4546>. doi.org/ 10.3895/rbect.v10n2.4546
- Lévy, P. (1999). *Cibercultura*. Editora 34.
- Marconi. M. A. & Lakatos, E. M. (2022). *Metodologia científica* (8ª ed.). Atlas.
- Mattos, S. G. (2022). *Em busca de compreensões sobre inteligência artificial e programação intuitiva na educação matemática*. [Tese de Doutorado em Educação em Ciências e em Matemática, Universidade Federal do Paraná]. <https://hdl.handle.net/1884/80496>.
- McIntosh, T. R.; Susnjak, T.; Liu, T.; Watters, P.; Halgamuge, M. N. From Google Gemini to OpenAI Q\* (Q-Star): A survey of reshaping the generative artificial intelligence (AI) research landscape. *ArXiv*, 1(1), 01-30. <https://arxiv.org/abs/2312.10868>. <https://doi.org/10.48550/arXiv.2312.10868>
- Midjourney. (2024). *Midjourney documentation*. <https://docs.midjourney.com/v1/en>
- Motta, M. S. (2021). Inovação no conhecimento científico por meio de pesquisas inventariantes: uma proposta de percurso metodológico para a realização de um mapeamento sistemático de literatura. In: Motta, M. S. & Kalinke, M. A. (Orgs.). *Inovações e Tecnologias Digitais na Educação: uma busca por definições e compreensões* (pp. 21-55). Life.
- Papert, S. (1986). *Logo: Computadores e educação* (2ª ed.). Tradução de J. A. Valente, B. Bitelman & A. V. Ripper. Brasiliense.
- Russell, S. J.; Norvig, P. (2022). *Inteligência Artificial: uma abordagem moderna* (4ª ed.). GEN.
- Santaella, L. (2023). *A inteligência artificial é inteligente?* Edições 70.
- Silva, S. de S. e. (2023). *Perspectivas teórico-filosóficas sobre a inteligência artificial à luz de Pierre Lévy: ontologia, desenvolvimento e possibilidades em processos educacionais*. [Dissertação de Mestrado em Ensino de Ciências e Matemática, Universidade Tecnológica Federal do Paraná]. <https://repositorio.utfpr.edu.br/jspui/handle/1/31795>.
- Vicari, R. M. (2021). Influências das Tecnologias da Inteligência Artificial no ensino. *Estudos Avançados*, 35(101), 73-84. <https://www.revistas.usp.br/eav/article/view/185034>. <https://doi.org/10.1590/s0103-4014.2021.35101.006>
- Zatti, E. A. (2023). *GenIA: plataforma para construção de objetos de aprendizagem de matemática que faz uso de programação intuitiva e é assistida por inteligência artificial*. [Tese de Doutorado em Ensino de Ciências e Matemática, Universidade Tecnológica Federal do Paraná]. <http://repositorio.utfpr.edu.br/jspui/handle/1/32509>.
- Zatti, E. A.; Kalinke, M. A. (2021). Inteligência Artificial na Educação Matemática: tendências ou entendências? In: Motta, M. S. & Kalinke, M. A. (Orgs.). *Inovações e Tecnologias Digitais na Educação: uma busca por definições e compreensões* (pp. 75-96). Life.