Linking AI in the pictogram design process. Case of study: type 2 diabetes mellitus

Vinculación de la IA en el proceso de diseño de pictogramas. Caso: diabetes mellitus tipo 2

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Abstract

Pictogram design is given in the Graphic Design Workshop I, allowing students to get closer to design methods and to the search for comprehension of the graphic solutions during their creative process. The aim of this project is to make an structured observation about the design process in students, by means of a comparative of pictogram design incorporating Artificial Intelligence (AI) and the proposals of its use, taking as parameter 51% of comprehension level from users. For the research design, a descriptive study with a mixed approach and non-probabilistic sampling was used; structured observation of the process and evaluation of six pictograms that communicate actions related to the care of type 2 diabetes mellitus. The results of this project support the hypothesis of AI as an auxiliary tool in the process of pictogram design, which is favorable for graphic representations related with drawing and perspectives, as well as the analysis and synthesis capacities in students. The article promotes the reflection so teachers could explore a more open posture to integrate AI into designers' educational processes.

Keywords: Comprehension, type 2 diabetes mellitus, Artificial Intelligence, evaluation method, pictograms

Resumen

En el Taller de Diseño Gráfico I se imparte el diseño de pictogramas, acercando al estudiante a los métodos de diseño y a la búsqueda de la comprensión de las soluciones gráficas durante su proceso creativo. El objetivo de este proyecto es realizar una observación estructurada del proceso de diseño de los estudiantes, mediante un comparativo del diseño de pictogramas incorporando la Inteligencia Artificial (IA) y las propuestas sin su uso, tomando como parámetro el 51% del nivel de comprensión por parte de los usuarios. Para el diseño de la investigación se utilizó un estudio de tipo descriptivo con enfoque mixto y muestreo no probabilístico; la observación estructurada del proceso y la evaluación de seis pictogramas que comunican acciones referentes al cuidado de la diabetes mellitus tipo 2. Los resultados del proyecto apoyan la hipótesis de la IA como una herramienta auxiliar en el proceso de diseño de los pictogramas, que favorece las representaciones gráficas relacionadas con el dibujo y las perspectivas, así como las capacidades de análisis y síntesis de los estudiantes. El artículo promueve la reflexión para que los docentes exploren una postura más abierta para integrar la IA en los procesos educativos de los diseñadores.

Palabras clave: Comprensión, diabetes mellitus tipo 2, inteligencia artificial, método de evaluación, pictogramas

Introduction

In the Graphic Design Workshop I course, corresponding to the second semester of the Graphic Design degree of the Benemérita Universidad Autónoma de Puebla (BUAP), a social issue is addressed as part of the didactic planning. In 2021 and 2022 preventive actions COVID-19 were promoted; in 2023, the focus shifted to preventing symptoms for anxiety and depression among university students. In the spring semester in 2024, actions that could prevent the onset of type 2 diabetes mellitus were selected and/or, in case of already being diagnosed, which favor the care for the disease.

The purpose of including a project of a social nature is based on the belief that graphic designers can actively and dynamically contribute in the search for visual solutions to social and complex issues, based on their knowledge and skills as designers and citizens. While fostering multidisciplinary learning in their role as trainees, it also encourages empathy and interest in taking responsibility for their role as visual communicators. Based on this, the topic related to the promotion of healthy behaviours was selected, considering that it deals with one of the diseases that claim more lives and demand more health treatment: type 2 diabetes mellitus.

In the visual communication and graphic design context, the ONCE Foundation, located in Spain, which propose the design of pictograms for all people. This was the result of the project known as *"Accesibilidad y capacidades cognitivas: movilidad en el entorno urbano (2008) and Biblioteca digital de recursos gráficos orientativos en accesibilidad cognitiva (2011)."* Both documented the design of inclusive pictograms through collaborative processes, resulting in a collection of pictograms that laid the foundation for a design method.

The concept of pictograms for all people pretends to be clearly perceived and understood by as many people as possible, highlighting two important moments during their design process: perception and comprehension, and the visual evaluation of the pictographic proposals.

The project not only presented visual solutions but also produced a publication documenting the design method and the guidelines during the evaluation process. This last ones can be a guide when designing pictograms. For example, emphasis is placed on the importance of including people with differences in age, gender and cognitive abilities, thus integrating

more and more people representing differet profiles in each project. The incorporation of the evaluation according to the regulations was another variable that was also integrated into the pictogram design, such as the reference of ISO 9186-1 and 9186-2, which establish the minimum number of people, conditions and criteria for the selected sample.

Regarding type 2 diabetes mellitus, the social issue addressed in the Graphic Design Workshop I, it is important to mention that it is one of the challenges for public health due to the premature mortality it cause. According to the Pan American Health Organization (PAHO), worldwide they exist more than 420 millions of adult persons with diabetes, while in the Americas it is estimated that 62 million people are affected (PAHO, 2023).

Living with this condition affects people's quality of life, since it generates disabilities that do not allow to those who suffer from it to carry out their daily activities or hold a job, in addition to the physical and emotional health complications of being dependent of primary caregivers. Factors such as overweight, obesity and physical inactivity are directly linked to chronic diabetes, as well as to the growth trend of the diabetic population.

In Mexico, despite the existence of various diabetes prevention campaigns, only one has been evaluated in terms of the level of understanding of the message and the reach achieved in the population. The evaluation was issued by the International Sanitary Supply Association (ISSA), which evaluated the health campaign "CHÉCATE, MÍDETE, MUÉVETE", launched in 2013, during the six-year term of President Enrique Peña Nieto. This campaign was designed with the purpose of slowing down the increase of overweight and obese population so that it would not develop into type 2 diabetes mellitus.

ISSA reported that the campaign reached 80% of the population aged 13 to 65 years, with a predominance of adult women. The results on the understanding of the campaign, according to the logo and the correspondence between the slogan and the images presented, showed that 9 out of 10 people in the selected sample, who achieved the medium to high levels of understanding of the campaign, while correctly relating the actions with the images presented (Salazar *et al.,* 2018). Despite the effectiveness of the campaign in outreach and understanding its message, by 2016 Mexico declared diabetes as an epidemiological emergency (Márquez *et al.,* 2022), which evidences the complexity of the problem and the need to continue with prevention strategies in the Mexican population that include different media and communication channels, as well as visual messages.

This project encouraged students to recognize the importance of evaluating the comprehension of the visual proposals, considering the complexity of the problem in which they intervene.

What is a pictogram?

The word *pictogram* derives from the etymology *pictus* (painted) and *grama* (graphic), which according to González and Quindós (2015) is the writing of figures or symbols. A pictogram is an iconic sign, that is, it uses the icon, which provides a graphic representation with a high degree of similarity to what is represented and thus seeks to convey a message in a simple, clear way, in order to transcend toward a universal language.

A pictogram should make reference to what is represented, from here we can see the *referent* which the ONCE Foundation (2011-2013) considers a basic element of the pictogram and that has to do with the real object or with the concept to which the visual sign refers. A pictogram articulates a series of graphic forms where, for didactic purposes of the Design Workshop, it presents graphic representations that fall within the following: a human performing an action, a human interacting with another human, a human interacting with objects and exclusive use of objects. This categorization allows students to decompose the message in order to project it into one of these categories that allow a better understanding for the user.

Comprehension

The *comprehension* criterion is defined as the level of recognition and assignment of meanings in relation to the projected visual representation. The closer the user is to the intended meaning, the greater the comprehension that a response from the user will entail. Therefore, it is proposed to include the evaluation of the design with final users, creating an interaction between designer (creator) and user (reader) to build a more functional and direct message.

When having a simple visual and direct language, the pictogram should transmit the message as directly as possible and achieve the best comprehension so that it can be considered functional. Thus, in this project it was used an evaluation format adapted from the intelligibility and comprehension test of Siebenhandl *et al.* (2007), which measures the recognition, comprehension and intelligibility with a scale from 1 to 10, to obtain the average of recognition, which determines the pictogram with more and least recognition according to the score obtained.

The assessment of pictogram comprehension changes in terms of the standards granted by the selected standard and the certifying institute. In the case of the ONCE Foundation, the standards 9186-1 and 9186-2 are taken. In this project, the criteria of standard 9186-1 were considered, which establishes that to validate a pictogram, at least 50% correct identification of the meaning must be achieved.

Pictogram design method

A pictogram should be an iconic representation understood by the majority of users who interact with it. In order to ensure that comprehension is established above the graphic and stylistic solution, the ONCE Foundation proposes a method for the design of pictograms that considers two relevant moments: the evaluation of comprehension and visual evaluation.

The evaluation of comprehension indicates that the minimum accepted sample will be 15 people, as long as they represent different profiles and stipulating at least 50% correct identification of the meaning for each pictogram. On the other hand, the visual evaluation determines an established format for each pictogram to be evaluated, limits the use of color to black and white proposals, and standardizes the distance at which the pictograms are displayed.

The method consists of seven phases, as seen in Table 1: "1. Search for references, 2. Documentation, 3. Graphic elements definition, 4. Conceptual design proposal, 5. Comprehension evaluation, 6. Visual evaluation and 7. final graphic design" (Fundación ONCE, 2013, p. 12).

Table 1. Phases of the ONCE Foundation method

Phases of the method	Description
1. Search for references	Determine objects, places, services or actions that require pictographic representation; their functions are described and analyzed.
2. Documentation	The main existent pictographic solutions are collected and selected in digital or printed documents of different sources. Working sheets are created.
3. Definition of graphic elements	The existing pictographic solutions are categorized and the necessary elements to include in the new proposal to be generated are selected.
4. Conceptual design proposal	Pictograms are sketched, including front, side, top and various perspectives, as well as graphic finishes.
5. Comprehension evaluation	The representative sample that includes the different profiles is determined, the evaluation format is applied, the pictograms that did not achieve the minimum understanding are identified and the observed adjustments are made.
6. Visual evaluation	Pictograms that did not achieve the minimum level of comprehension are re-evaluated, with the corrections made, and readability is assessed in a long-distance legibility test. The indications of the ISO 9186-2 standard are integrated.

7. Final graphic design	After identifying the arising observations from the evaluation of phases 5 and 6, the validated set of pictograms is presented and the digital files are prepared for production and delivery.

Source: Compiled by author with information from ONCE Foundation.

Artificial Intelligence

Artificial Intelligence has aroused the interest of creatives and professionals in the design sector. The emergence of and access to Generative Artificial Intelligence (GAI) revolutionized the way content was generated by writing *prompts*. Although design *softwares* were already integrating AI actions, it was DALL-E and Midjourney that generated most of the attention (Brandemia, 2023).

The GAI has the ability to simulate human intelligence, it is adaptive and solves by simulating the human mind based on cognitive domains. What is interesting about this type of artificial intelligence is that it integrates, in the solutions, sensory perceptions such as color, sound, depth, images, dimensions enabling it to create paintings, songs, videos, original images that place human creative work on a very fine line.

AI, in the educational field of design, can help teachers to favor teaching-learning processes, by improving students' ways of learning, time management in terms of tasks and actions, as well as supporting students with technical tools, data collection and information interpretation.

Ge and Fan (2024) conducted a study to demonstrate through a literature review the impact of AI in Design education, considering the challenges faced by teachers in the choice of AI tools and techniques. The study provides three directions: integrating AI to improve design outcomes in visual representation, AI as a teacher's aid in teaching practice, and AI to support the design process. The authors conclude by mentioning that, despite the challenges and speculations that AI awakens in design students and professionals, after its use, there is a significant improvement with respect to originality, practicality, production capacity and aesthetics in the visual results. However, authors also think about the importance of continuing doing investigations that contribute to the guidelines identified and to new paths that strengthen the teaching-learning of design.

In consideration of the analysis made to the implications in the use of AI in the academic training of designers, this project studies how to incorporate AI in the Graphic Design Workshop during the pictogram design process to identify the qualities and opportunities that AI provides for the benefit of graphic design students.

In the medical area, AI has been used in scientific research (Ahlqvist, 2018 cited in Manzini *et al.,* 2022) and in the development of digital

applications that interact with patients and doctors, which opens the opportunity for graphic design to intervene with functional visual solutions, relevant to the user.

Material and method

In this project, in addition to working with the ONCE Foundation method, the use of Artificial Intelligence was included as a tool integrated into the pictogram design process to obtain a visual solution, so the help of Microsoft Copilot was integrated during the graphic element definition and conceptual design proposal phases.

Two solutions and two evaluations were obtained corresponding to identifying the design guidelines, based on the students' autonomous design process, under the ONCE Foundation method and the design process integrating AI.

General objective

To carry out a structured observation of the design process of the students by comparing the design of six pictograms that inform prevention actions for type 2 diabetes mellitus in two proposals, one that includes AI and the other without the use of AI, using as the benchmark 51% of the level of comprehension in users from 18 to 65 years old.

Specific objectives

1. To design pictograms for the referents: Check your blood sugar levels; follow a healthy diet; exercise frequently, maintain a healthy weight; see a specialist and reduce alcohol and soda intake, following the method proposed by the ONCE Foundation.

2. Link AI as a tool during the pictogram design process, in accordance with the ONCE Foundation method and in the phases that allow its support.

3. Use the comprehension test to digitally evaluate the comprehension of 30 pictograms in two groups: a) series without including the ia and b) series using AI; in a convenience sample under the requirements, according to the standard established by ISO 9186-1.1.

Participants

In order to fulfill the main objective, the research used was descriptive, with a mixed approach, under a non-probabilistic sampling. The requirements proposed by the ISO-9186-1 standard were taken, which allows a minimum sample of 50 people. It was determined for this project that

each group would evaluate at least 20 people, with different profiles in terms of age, gender, cognitive, cultural and educational conditions. The criteria to be chosen were the following:

A) Gender

B) Age: 18 to 65 or more

C) Occupation: students, professionals, housewifes, any type of activity that generates financial income.

D) Language: spanish

E) Any differentiated capacity

With these criteria, a sample of 100 people with representation of the five established criteria was obtained.

Work groups:

Five groups of students with six members were randomly assigned one of the six type 2 diabetes mellitus prevention actions. Table 2 briefly describes how the ONCE Foundation (2013) method for pictogram design was applied.

Table 2. Implementation of the Method

Design method phases	Taks and actions
Search for referents	Referents were assigned after defining the prevention actions for the care and maintenance for type 2 diabetes mellitus that resulted from the analysis of the problem.
Documentation	Each student was asked to collect 15 pictographic solutions for each assigned action; applied in different surroundings: health, sports, marketing, campaigns, in different levels of iconicity. Also the documented each of the pictographic solutions in one card.
Graphic elements' definition	The students selected the graphic elements that were more used for pictographic solutions and the visual resources that favored the visual resources that favored to a greater and lesser extent the pictogram to be visible and legible, from which they defined the graphic elements.

Conceptual design proposal	They started their sketch process of the pictogram: styling, proportion, perspective, type of figures and finished products. They achieved three categories: a human developing an action, a human interacting with an object and an object as a representative of the action or interaction.
Evaluation of the comprehension	The first stage of evaluation included six variants for each action, with five work teams, resulting in a total of 30 pictograms that were evaluated in digital format by a sample of 20 people with different profiles and under the assigned criteria.
Visual evaluation	Two digital evaluations were carried out as a result of applying the Copilot AI in phases 3 and 4 of the method Evaluation A corresponding to the autonomous process of students in all phases of the method, validating six referents of the solicited sections, in five groups, with a total of 30 pictograms. We used the format adapted from the comprehension and intelligibility test of Siebenhandl *et al.* (2007), rating comprehension on a rating range of 1 to 10 to obtain the percentage of comprehension of each pictogram (see Figure 1). In evaluation B, as AI, Microsoft's Copilot was integrated in the graphical item search phase and conceptual design proposal phase. The first sketch and drawing phase was guided by Copilot; subsequently, students digitally drew and solve the composition with the necessary elements. Six referents were also obtained for each action in five groups, with a total of 30 pictograms that were digitally evaluated with the comprehension test following the same format as in evaluation A.
Final graphic design	30 pictograms were evaluated without using artificial intelligence and 30 pictograms using AI. After the evaluation, a battery of 27 pictograms without AI support and 30 pictograms with AI support were obtained.

Source: Compiled by author

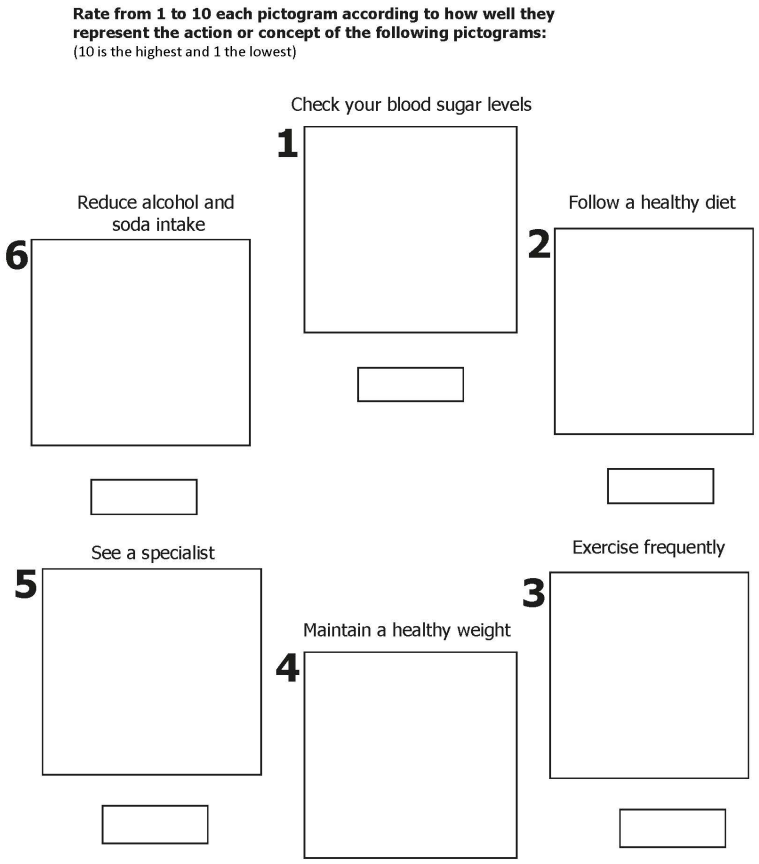


Figure. 1. *Adapted format of the comprehension and intelligibility test. Source: Compiled by author with information from Castrezana, 2016.*

Results

Following the format of Siebenhandl *et al.* (2007), a numerical rating scale from 1 to 10 was used. Each of the 20 participants assigned scores to the six pictograms for their respective group. An average was calculated and expressed as a percentage, based on the ISO-9186-1 Standard, which governs the ONCE Foundation method, indicating 51% as the minimum criterion for evaluating the comprehension of the pictograms, rejecting the pictograms that did not obtain the minimum percentage required and accepting those that surpassed it. The results of the two evaluation groups are presented below.

Group A: Evaluation of the comprehension in the six pictograms without the intervention of AI

Five series with six pictograms were presented and evaluated using the adapted format of the comprehension and intelligibility test (see Figure 1). From the 30 pictograms evaluated, and according to the minimum comprehension criteria requested, three pictograms were rejected. Figure 2 shows them arranged in three categories: human performing some action, human interacting with an object and object as a representative of the action or interaction.

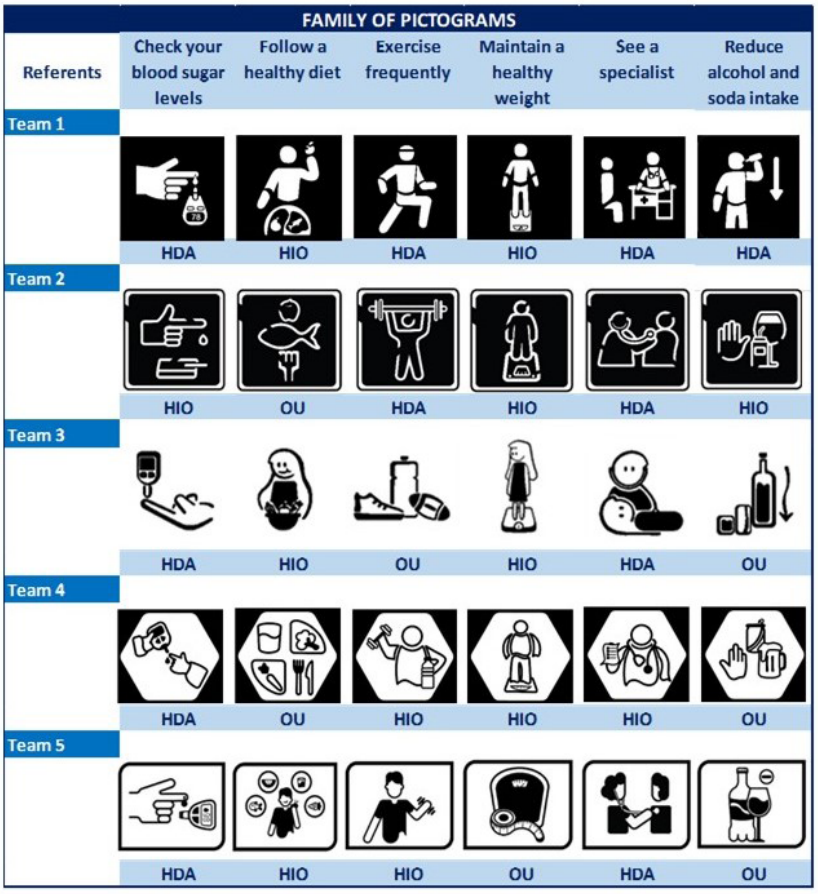


Figure 2. *Family of pictograms from group A.*
Source: Compiled by author.

In the solution proposed by the students, the category "human interacting with the object" (HIO) was the most used at 40%, followed by "human developing the action" (HDA) with 36.6% (see Figure 3).

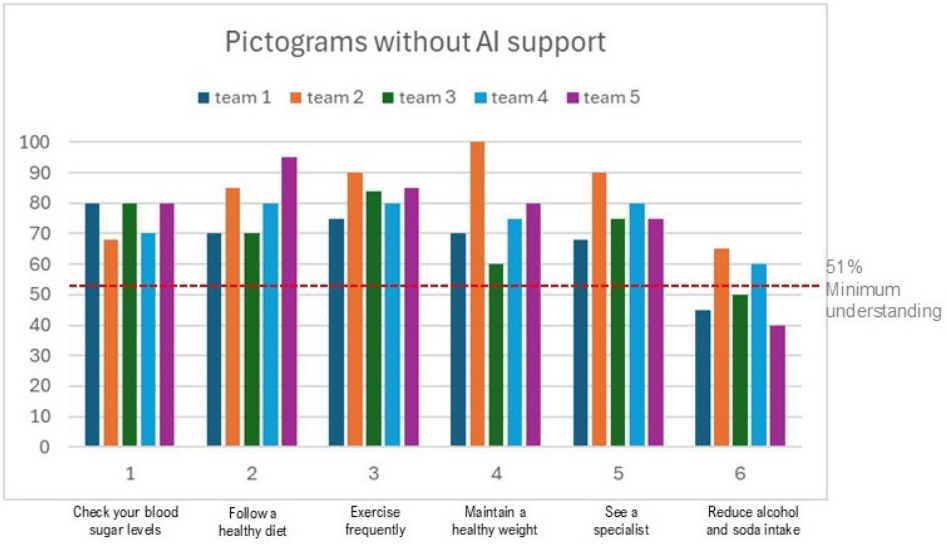


Figure 3. *Comprehension in percentages of the pictograms of group A. Source: Compiled by author.*

According to the percentages determined by ISO 9186-1 and the ONCE Foundation, 51% of comprehension is required to be accepted; therefore, as shown in Figure 3, the reference "decrease the intake of alcohol and soft drinks" in teams 1, 3 and 5 did not obtain the minimum level of comprehension. This referent combined two elements in the same action and represented a recommendation that users were less familiar with. In the documentation phase, incomplete and separated images were obtained, which made their representation more complex for the students (see Table 3 and 4).

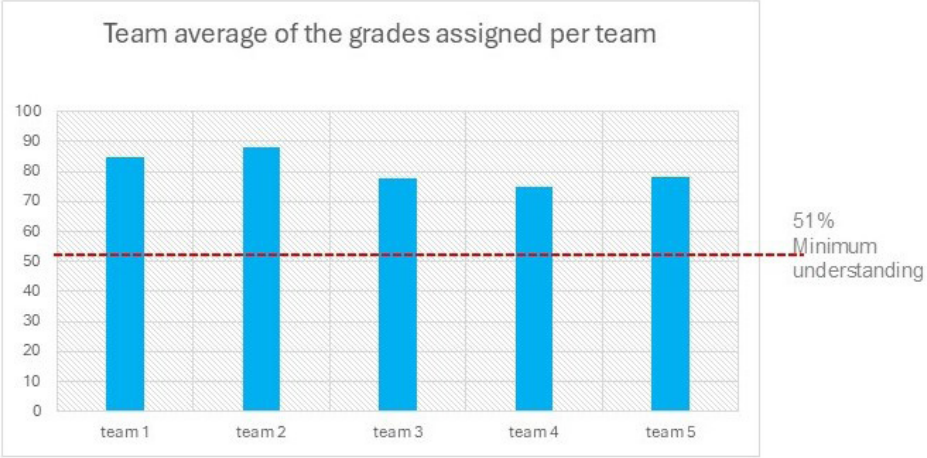
Table 3. Pictograms that need to be redesigned due to lack of comprehension.

Group	Pictogram	Pictographic style	% Comprehension
1	Reduce alcohol and soda intake		45%
3	Reduce alcohol and soda intake		50%

5	Reduce alcohol and soda intake		40%

Source: Compiled by author.

Table 4. Team average of the grades assigned to group A



Source: Compiled by author.

It is observed that team 2 obtained the highest average number of scores assigned in the Siebenhandl *et al.* test, achieving 83 compared to team 1, which obtained 68. Teams 2 and 4 obtained the six accepted pictograms, meanwhile groups 1, 3 and 5 achieved five pictograms. The referent "exercise frequently" received the highest recognition and comprehension, followed by the second referent: "follow a healthy diet."

Group B: Comprehension evaluation in the six pictograms with AI intervention

The same scheme of group A was presented: five series with six pictograms, which were evaluated using the adapted format of the comprehension and intelligibility test (see Figure 1). From the 30 pictograms evaluated and in accordance with the minimum required comprehension criteria, none was rejected, resulting in a battery of 30 pictograms. Figure 4 shows them arranged in three categories: human performing some action, human interacting with an object and object as a representative of the action or interaction.

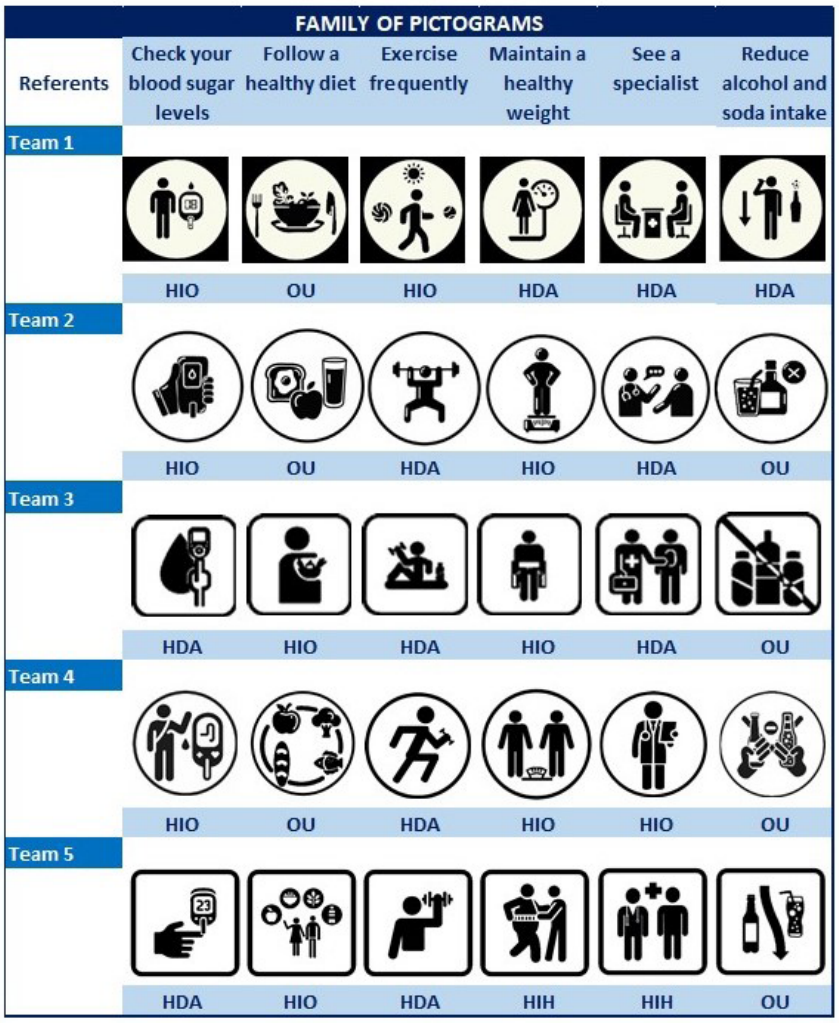


Figure 4. *Family of pictograms of group B.*
Source: Compiled by author.

In group B, the solution proposed by the students used the category "human developing the action" (HDA) the most, with 36.6%, followed by "human interacting with the object" (HIO), with 33.3%. However, in this group, which used AI as support to create the pictograms, a new category emerged: "human interacting with another human" (HIH), which had not been a category used by students in previous projects, nor by group A.

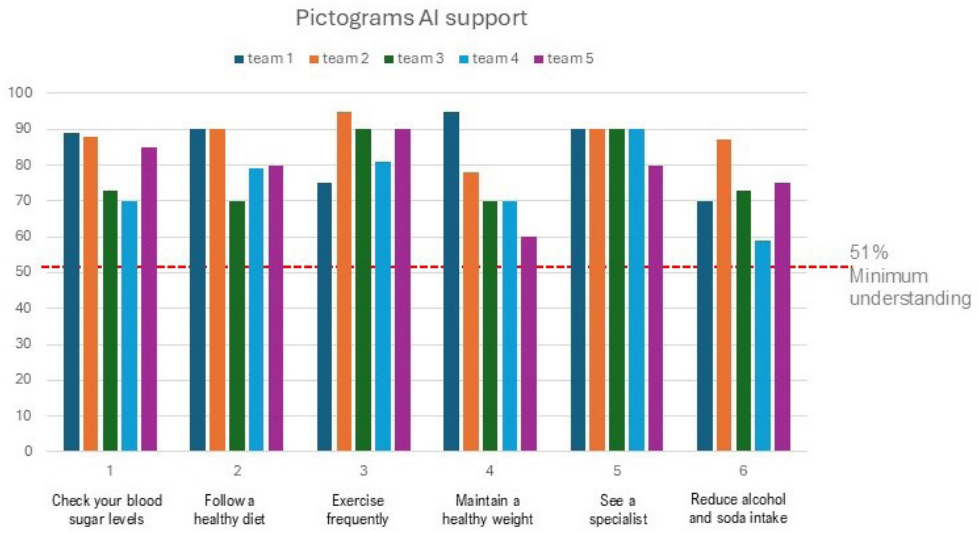


Figure 5. *Comprehension in percentages of the pictograms of group B. Source: Compiled by author.*

As can be seen in Figure 5, the 30 pictograms obtained more than 51% of comprehension in the ratings given by the users, and there was an increase in the rating assigned to each referent. However, it is still possible to note that the referents "maintain an adequate weight" and "decrease alcohol and soft drink intake" were the ones that obtained scores below 6, requiring teams 4 and 5 to make visual improvements to the pictograms (see Figure 6).

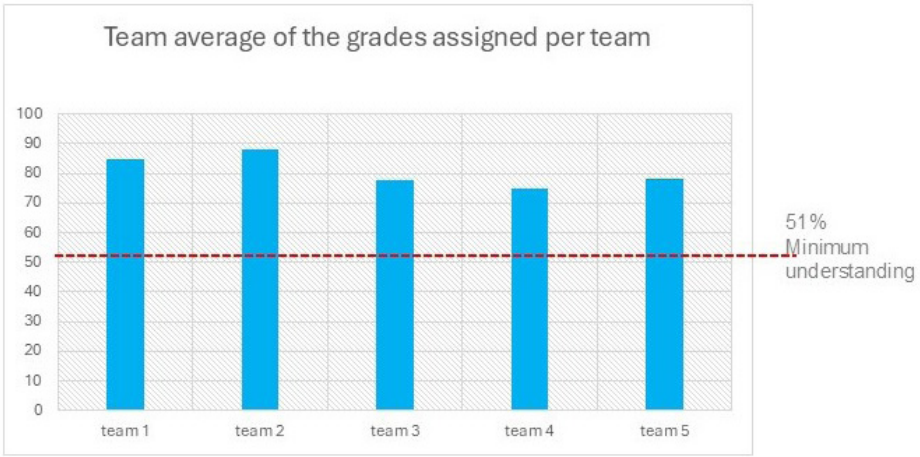


Figure 6. *Team average of the grades assigned to group B. Source: Compiled by author.*

Compared with group A, it can be seen that in group B the scores given were higher: team 2 obtained 88, followed by team 1 with 84. Team 4 obtained the lowest score. It can be noted that in group A most of the teams remained just above 70.

In conclusion

When designing a pictogram or a family of pictograms, it is essential to consider the users' understanding of the visual representation. The ONCE Foundation method allows the designer to follow design guidelines to achieve greater functionality to identify, recognize, repeat actions, services, objects, people and places in direct relation to the meaning and its interpretation.

In this particular case, which is aimed at promoting actions and health habits to prevent the onset of type 2 diabetes mellitus, the proposal to design a family of pictograms is intended to complement the information on the condition, but above all to insist on following indications with simple and clear images that reinforce daily living habits.

In this way, the development of a social project, as part of the didactic strategy of Graphic Design students, contributes to strengthen the social, ethical and professional responsibility of the designer, in addition to reinforcing technical, creative and communication skills and knowledge.

The ONCE Foundation's method allows introducing a practical discipline for the design and conceptualization process of Graphic Design students, involving them with the skills of documentation, analysis and synthesis of information and, above all, bringing them closer to design evaluation, which is a strength to acquire the designer's metacognition in terms of the reflection of designing with purpose.

The introduction of AI to second-semester students as a support tool generated at the beginning an estrangement about its use and how to implement it without feeling invaded or overwhelmed by it. However, when used after carrying out their design process, according to the ONCE Foundation method, including an evaluated proposal, it gave students greater confidence and understanding of what a pictogram is and how it should be designed. Thus, by using the ia as part of the documentation, analysis and selection stage of the images generated by the GAI, they were able to realize that most of the images did not meet the criteria to be pictograms.

Group A, specifically team 1, presented challenges in the drawing and perspective of the human figure and the objects that made up the pictogram, while the students of team 3 had difficulty in finding the design style with the characteristics and expressive qualities that should be present in all the pictograms that made up the family. Teams 2 and 5 solved their pictograms with a higher unity of design features.

Teams 1, 3 and 5, in the reference “decrease alcohol and soft drink intake”, did not achieve the minimum 51% of comprehension required to be accepted. Despite team 5 didn't have any problems of graphic representation of the objects, the message wasn't completed by the user. This fact is related with the lack of more information on the users, unlike the referents: “exercise frequently” and ‘follow a healthy diet’, which

are widely disseminated by doctors or in mass messages employed in the health field. This supports the idea that the design guideline should work on the convention and familiarity of a referent as an indispensable point to achieve understanding and acceptance of a pictogram, as concluded by Fernandez *et al.* (2015) in the evaluation conducted on the understanding of pictograms used in the cleaning sector.

Group B, which introduced the support of AI during its design process, specifically in the stages of defining graphic elements and proposing the conceptual design, achieved an improvement in the acceptance of the 30 pictograms. 70% of the visual solutions integrated the human figure, so the categories of "human developing the action" (HDA) and "human interacting with the object" (HIO) were mostly used, and even the category "human interacting with another human (HIH) appeared as students improved the drawing, proportions and perspective of the elements, overcoming the deficiency of the drawing of the human figure due to the integration of AI; however, there was no visual proposal of a design style and a representation far from the style of the pictograms recognized as universal, which caused frustration in the students. Thus, the students chose the options proposed by AI in relation to the similarity of the actions and objects to be represented and achieved uniformity of features in the family when making the digital compositions, but they did not consider them more creative or original. This group also reduced the time of the design process, since they were familiar with the ONCE Foundation's method and having achieved the previous proposals, they knew what they had to request from AI and the conditions to design a family of pictograms.

It is important to point out that team 2 achieved the highest scores in group A and B, while teams 3 and 4 maintained a regular performance, team 5 achieved better visual results and scores without the support of AI and team 1 achieved a higher performance with the support of AI.

As this was the first time that students incorporated AI as a tool in the design process, they did not have the necessary information about AI and there was some resistance to using it, although some integrated it more fluently. Therefore, the form of interaction must be planned and, prior to this, the students must be trained to a greater extent in order to obtain a better performance from the tool.

Finally, using a comprehension test to evaluate design proposals allowed students to engage with the user, with the message and with the functionality of the visual representations, also giving them greater certainty to their design proposals, as well as preparing them on the importance of user research. This project was satisfactory for the evolution of knowledge and skills in the subject of Graphic Design Workshop I, corresponding to the design of visual signs.

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