Metaphors Applied to Interaction Design in Group Learning

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Abstract—The acquisition of the ability to use metaphors effectively contributes in increasing students' capacity to analyze and design interfaces. The use of metaphors in interaction design offers consistent interfaces, simple and intuitive. However, it is not easy for students to learn how to use metaphors in interaction design. To teach students how to develop interactive experiences through metaphors is not an easy task. This paper proposes a method for teaching the use of metaphors, while designing the website, desktop, mobile or tablet interface and presents the results of a case study on the successful teaching method proposed. The teaching method developed is a collaborative learning model based on model of King questioning and creative dimensions of Ferreira. It consists of creative tasks coupled with structured questionnaires with questions and are designed to encourage interaction, group learning, and foster creativity of students.

Keywords-metaphors; interaction; design; teaching; learning

I. INTRODUCTION

Metaphors create connections between concepts that are already familiar to people. Metaphors explore the existing knowledge of each person to assimilate something new. Thus, the person is able to learn new things, using their previous knowledge of the world [1]. This means that the person will be able to understand and experience one kind of thing in terms of another [2]. Considering interaction design, it is desirable to provide an interface familiar to the user, easy to learn and use.

The use of metaphorical concepts is one of the resources available for creating intuitive user interfaces, simpler to learn and use. Entertainment websites, online stores, social networks, and others require an interface easy to learn and use. The interaction design should be well organized, easy to be interpreted and used by the users. Metaphorical concepts can be used in an expressive way to achieve this goal. Metaphorical concepts are pervasive in the culture of a society. Lakoff and Johnson [2] stated that metaphors are concepts inherent to subconscious and govern our whole way of thinking. Thus, the good use of metaphors in interface design is a feature that will make the interaction much easier to understand. Nielsen and Molich [3] established that we should minimize the cognitive load of the user. In other words, they stated that the designer should facilitate the reasoning required to interpret an interface. Also, they state

that, in a user interface, there must be a match between the system and the real world. The designer should use phrases and concepts familiar to the user, rather than system-oriented terms.

The use of metaphors is a powerful resource that can be applied to achieve these heuristics. The appropriate application of metaphorical concepts turns an interface into a better interface. The interface design consists in defining how content is organized and presented to the user [4].

The consistent use of metaphors in the context Human Computer Interaction (HCI) helps to reduce the cognitive load necessary for understanding the functionality of a computational interface. Students´ understanding about a good usage of metaphors in HCI improves their ability to properly critique and design computer interfaces.

The use of metaphors is evident in many patterns and interaction interface designs. Some examples of the use of metahpors in HCI are evident at Apple's desktop, pattern wizard, canvas plus pallet pattern, menus, buttons, dashboards, carousel pattern, breadcrumbs pattern, and so on. But, how to apply metaphors in interaction design is nota easy to learn, the metaphors may have simple literal comparisons and complex connections [1]. In addition, there are misleading uses of metaphors. It is not simple for students to learn how to use metaphors in interaction design. To teach students to develop interactive experiences by means of metaphors it is not an easy task. Students need to understand user experiences, concerns, skills, interests and expectations and must develop the ability to create good designs based on user's knowledge.

Constructing effective metaphors is to some extent a complex skill because it depends on the creative ability of designers to see new analogies, in order to choose the right set of correspondences. These correspondences have to enhance some aspects and hide others, because metaphorical mediation carries elements of the concept that are consistent, but also inconsistent when using metaphors to comprehend one thing in terms of the other. For Schwartz and Fischer [5], metaphors highlights levels of complexity as well as the need for sufficient support to build complex understandings, but they do not easily capture the diversity of contexts that students might experience that could lead to the same abstraction. One of the reasons why metaphors can be difficult to learn and teach, it is because they have a high

level of complexity. Another reason is that students may have different interpretations, which makes teaching difficult.

According to Hodges [6], if we examine the metaphor closely, their connotations are often the darkest when applied to teaching. Having a problem in one's research is motivating; having a problem in one's teaching is, well, a problem. In order to overcome the difficulty to teach metaphors in HCI, we suggest the teacher must apply a teaching method that encourages creativity and also criticism in interaction design.

In this work, we aim to awaken and stimulate the use of metaphors in teaching and learning interaction design with the aim to stimulate students' abilities to discern what is a good or bad design, allowing students to differentiate an interaction design that it is aesthetically good but possesses a bad functional design, and to propose new ideas and solutions.

In this work, we present an innovative teaching method to teach metaphors in human computer interaction design that fosters student's creativity and criticism. This method is based on collaborative learning and creative dimensions proposed by Ferreira [7] and the discussion method proposed by King [8], as shown in Fig. 1.
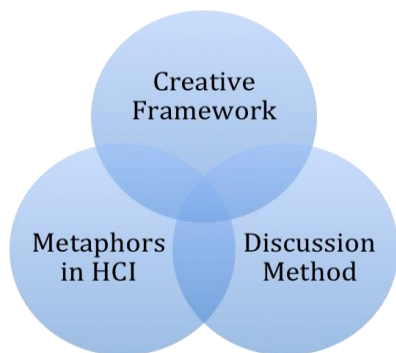

Figure 1. The proposed teaching method.

The creative dimensions, proposed by Ferreira [7], contain underlying dialogical processes that align dialogues with mental processes linked to both adaptive and innovative creativity. The creative dimensions constitute a pedagogical framework for designing exercises when teaching human computer interaction. They make it possible for teachers to create significant collaborative learning experiences to students, fostering them to activate mental processes underlying creativity during discussions.

On the other hand, in the discussion method group proposed by King [8], questions that trigger patterns of discourse in learning groups are designed to facilitate the construction of complex knowledge and problem solving.

Our teaching method proposes a combination Ferreira's framework [7] and King's [8] types of questions to propose a repertory of interaction design exercises exploring the use of metaphors. In our teaching method, we also approach the most common metaphorical concepts as structural, visual, functional, and positional metaphors, and consider where,

when, why and how they are applied in the field of HCI. This metaphorical knowledge is part of the teaching method and is used during the tasks and questions created.

Their use can improve the computational interface and provide substantial gains in user productivity.

For example, visual metaphors are widely used in comic books. When a certain character is nervous, he is represented by a rough facial expression and smoke coming out of his ears, as shown in Fig. 2.

Figure 2. By means of prior knowledge acquired from the culture to which we operate, we recognize immediately that the character is nervous.

The Pinterest [9] website contains a virtual panel that makes possible to create image categories, including descriptions and comments. In this website, we have a visual metaphor that allows the user to act like in a real picture panel.

An example of positional metaphors application in interaction design is that the most important items must be at the top of the screen. This rule is very important in mobile applications.

In the LinuxMall [10] website, it is clear the use of functional metaphors. In this site, there is a backpack in the upper right corner, which suggests the user to place the desired products inside it.

As an example of the application of structural metaphors, commonly, an e-commerce website is subdivided into sections like in a real store.

In this work, we present a case study comparing the teaching method proposed in an undergraduate HCI class (treatment group) and a method involving students' discussions and informal teacher mediation in another undergraduate HCI class (control group). The case study conducted showed significant results.

In Section II, we show the importance of the application of metaphorical concepts to human computer interaction and show systematic aspects of metaphors. In Section III, we describe the teaching method proposed in this article. In Sections IV and V, we present a case study of the application of the teaching method proposed and the results obtained.

II. TEACHING METHOD FOR USE OF METAPHORS

The use of metaphors is essential for the user experience to become simple and intuitive. It facilitates user understanding and interactivity. According to Baumer [11], metaphors can be powerful aids for understanding because they can help the understanding of novel concepts.

However, learning to apply metaphors in computing environments is a difficult task. Although metaphors abound in human thinking, they can be surprisingly difficult to notice simply due to their ubiquity.

In this work, we developed a teaching method based on collaborative learning for teaching metaphors in interaction design. Collaborative learning is a successful method to awaken creativity. Creative solutions emerge from interactions that encourage students to express and evolve their ideas in specific problems.

According to Jonassen and Land [12], knowledge originates from productive discourse among individuals, the social relationships that bind them, and the physical artifacts, theories, models and methods that they use and produce. Productive discussions provide satisfactory results in collaborative learning, providing students the opportunity to share and co-construct knowledge.

Creative solutions are built during joint activities that trigger productive discussions. Creative and collaborative dimensions proposed by Ferreira [7] promote productive discussions, where students are encouraged to widen and deepen the design space. Students extend the design space when a new idea emerges and deepen the space of the project when an idea is developed.

Ferreira´s pedagogical framework allows the teacher to elaborate tasks that nourish creative discussions during collaborative problem solving in interaction design [7]. The author considers that creative products occur as stimulation of many different planes. The framework contains seven collaborative and creative dimensions to be applied by the teacher. According to Ferreira [7], the dimensions are: immersion, unpacking opportunities, exploring complementary ways, surpassing limits, expanding, discovering and developing unpredictable places. The dimensions contain dialogic processes that are dialogs aligned with mental creative processes associated to both adaptive and innovative creativity. Dialogic processes facilitate students to elaborate ideas built on other ideas, during their collaborations. The framework helps and challenges teachers to be aware of how complex students´ activities can be elaborated during collaborative learning. Considering students perspectives, during productive discussions they are able to detect relevant and irrelevant information, recognize the familiar, deal with new information, adapt and reapply techniques, among other creative important processes.

The use of provocative questions is another strategy that encourages students to interact productively. The students absorb and transcend knowledge when they engage themselves in profitable interactions.

King´s model approaches provocative questioning to induce relevant cognitive, meta-cognitive and socio-cognitive processes in participants [8]. Effective learning interactions induce complex cognitive processes including the analytical thinking necessary to create metaphors.

According to King [8], learning is constructed during interaction with others. During the interaction the students engage in the exchange of ideas, opinions and perspectives. The speech is composed of provocative questions, explanations, justifications, assumptions and conclusions. The construction of knowledge occurs when students explain concepts to each other. The questioning is a procedure that asks questions and answers. The interaction during the

discussion results in a high level of learning. The model proposed by King consists of structured questions on issues of entry [8]. For example:

- How much similar to?
- How does it relate to?
- What do you remember and why?

Comprehension questions, for example:

- What does it mean?
- What's important for?

Connection questions, for example:

- How is similar with?
- What is different between?
- How can it be used for?
- What are the strengths and weaknesses?

The method proposed in this paper involves the development of group assignments focusing on the use of metaphors in HCI. Using our method, the teacher is able to elaborate group tasks and questions that encourage students engage themselves in productive discussions.

The teacher is invited to approach the dimensions proposed by Ferreira [7], questioning the model proposed by King [8] and knowledge about metaphors when designing exercises.

This way, the students have the opportunity to scrutinize metaphors in different contexts and are urged to find solutions and improvements in the application of metaphorical concepts in interaction design.

III. THE CASE STUDY

The case study aims to examine the effectiveness of teaching the use of metaphors in interaction design by means the proposed teaching method.

In this preliminary case study, four tasks based on the proposed method were analyzed. The preliminary results indicated that the proposed teaching method has potential to help teachers to mediate students' creativity when using metaphors in interaction design.

The students investigated were engaged in two classes of undergraduate Software Engineering at Federal University of Goiás in 2011 and 2012. There were 44 students in the class of 2011 and 42 students in the class of 2012. Each class was divided into groups of 6 (six) students and each group was evaluated by means of discourse analysis of online discussions.

A. Students' Profile and Communication Tools Used

Students are studying Software Engineering at the Federal University of Goiás. Students have the profile of software developers. They are learning about the concepts related to interface design, such as metaphors, usability guidelines and interaction patterns in the human computer interaction design course.

The communication tool used was the Moodle platform, which facilitates iterations among students. Each student posts messages concerning their responses and opinions. Moodle is a tool for course managing that can also be used

for distance learning. Using the forums, the student can post a message at any time and place.

B. Description of Tasks (Treatment Group)

The tasks required are described following.

1) Discuss having in mind the questions related to the website Taisho [13].

Express your opinions and inferences, and propose appropriate solutions. In the following, we describe the questions regarding the Taisho website:

Why is it important to use a visual metaphor on the website? Are the elements observed on the website similar to real objects? How does the geisha and the shamisen relate to each other? Is the menu contained in the Website an example of positional metaphor? Did the visual metaphors facilitate user interaction in the website? Are the metaphors used readily apparent to any user? Why the metaphors were used? How each metaphor does interfere with the user's perception? How are the used metaphors similar to elements of everyday life? Are the metaphors used inherent in the culture of the target audience? What are the strengths and weaknesses of the use of visual metaphors in the website? Is the user able to associate the elements present in the metaphorical interface actions and objects represented? Does the website have a stable context? Does the positioning of the metaphors in the interface facilitate the identification of the company name? Does the name have a reasonable size and its location is noticeable? Are the different metaphorical elements in harmony? Do these elements contribute to the user understanding about the information contained in the website? Does the interface emphasize the services offered by the company? Are the interface services clear from the user perspective?

2) Discuss having in mind the questions related to the websites Sitotis [14] and Thedeepestsite [15].

During the discussions, you must engage critically and constructively with the ideas of others. Express your opinions, inferences, and propose appropriate solutions. In the following, we describe the questions regarding the websites:

The metaphor used in the logo of the company contributes to the understanding of company activity? Is it possible to satisfactorily answer the purpose of the website? Is the website interface sufficiently self-explanatory? Do the metaphors present in the website immediately contribute to the understanding of its interface? Do you understand the services offered by the website? Does he position of the website menu help the user to find the desired options in a simple and immediate manner? Can the user effortlessly navigate in the website? Is it able to distinguish the options? Is there a precise notion of what is in each option? Do the graphics and animations present on website show the actual content? Do the metaphors used emphasize a content or are merely illustrative? Is the user able to associate the elements present in the metaphorical interface actions and objects that they represent? Are the functional metaphors clearly perceived? Is the website interface sufficiently self-

explanatory? Do the metaphors present in the website immediately contribute to the understanding of its interface? Can the user effortlessly navigate the website? Is the user able to distinguish the options?

3) Choose a Website to design your Mobile interface.
a) Take a look at the patterns shown in classes concerning mobile and navigation patterns. Also, take a look at the supplementary bibliography.
b) Use metaphors in the design of the website. Discuss having in mind the usability guidelines, particularly guidelines for mobile interfaces. Think outside the box when designing the website. Consider the following questions about metaphors:

- What types of metaphors are more suited to the context of your mobile interface?
- Do the metaphors used help the user to concentrate on the main service offered by the website?
- How visual metaphors can be used to enhance the understanding and simplicity of the website in a mobile environment without sacrificing your design?
- Is it possible to use metaphors to emphasize most relevant content to users?
- How can we subtly integrate metaphors and the graphic style of the website?
- Does the metaphors used provide users a logical path to follow, minimizing the effort required for understanding, making navigation easy and obvious?
- What functional metaphors can be used to facilitate the execution of some tasks?
- Can he use of metaphors make navigation easier and more intuitive for the user?

4) Each student must individually choose a context to adapt the wizard pattern using metaphors.
Defend your choice in your group grounding your arguments on the items "when" and "why" of the pattern. Each student must design a wizard and defend his idea, based on item "as" the wizard should be implemented. Discuss, choose and refine the best idea considering the in the following questions:

- Does the Wizard makes clear to the user what is the goal to be achieved?
- Is the user notified if he tries to start a new job before completing the current?
- Does he user have the option to go back and change the data entered in the previous step?
- It is visible to the user what is missing to achieve the goal?
- The Wizard is simple and intuitive and does not require much effort from the user understand how to use it?
- Do the metaphors used help the Wizard to became more simple and intuitive?
- Do the metaphors used help the user to concentrate on the goal to be achieved?
- Why metaphors were used? Do the metaphors significantly help the user reach success in every step and fulfill the purpose of the Wizard?

C. Description of Tasks (Control Group)

The tasks were in accordance to the following collaborative script:

Read a text about metaphors and evaluate the use of metaphors in the Websites Taisho and Sitotis. Based on the text and previous classes on this subject, express your opinions regarding the use of metaphors in the Website.

D. Used in the Discourse Analysis

The model used in the discourse analysis was proposed by Newman, Webb and Cochrane [16] and is described by ten categories:

1) Relevance: Relevant states or diversions.

2) Importance: Important points and issues or unimportant points and trivial issues.

3) Novelty, new info, ideas, and solutions: New problem-related information or repeating what has been said.

4) Bringing outside knowledge or experience to bear on problem: Drawing on personal experience or sticking to prejudice or assumptions.

5) Ambiguities: clarified or confused: Clear statements or confused statements.

6) Linking ideas, interpretation: Linking facts, ideas and notions or repeating information without making inferences or offering an interpretation.

7) Justification: Providing proof or examples or irrelevant or obscuring questions or examples.

8) Critical assessment: Critical assessment or evaluation of own or others' contribution or uncritical acceptance or unreasoned rejection.

9) Practical utility (grounding): Relate possible solutions to familiar situation or discuss in a vacuum.

10) Width of understanding (complete picture): Wide discussion or narrow discussion.

Categories 1 to 9 were explored in this case study.

E. Model Used in the Creativity Analysis

The model used in the analysis of creativity was proposed by Zeng, Salvendry and Zhang [17]. This model was structured in a checklist for web site design. The checklist comprises:

1) Aesthetically appealing design: artistic, colorful, energetic, beautiful, fascinating, entertaining, engaging, attractive, favorable, and desirable.

2) Interactive design: interactive, animated, available multimedia, and dynamic.

3) Novel and flexible design: unique, appealing, and flexible.

4) Affective design: stimulating, pleasing, delighting, and exciting.

5) Important design: relevant, important, and crucial.

6) Common and simple design: infrequent, unique and sophisticated.

7) Personalized design: personalized.

F. Model Used in the Questions Analysis

In the analysis of the questionnaire, were used dimensions of User Experience (UX) involving [18]:

1) Immersion and Flow: While the user is using the system he forgets everything around him.

2) Tension: The user feels tense while using the system.

3) Competence: The user thinks that he is good at using the system.

4) Negative Affect: The user feels bored while using the system.

5) Positive Affect: The user has fun while using the system.

6) Challenge: The user makes effort while using the system, but he takes pleasure in overcoming obstacles.

7) Fellowship: Good experiences are produced during social interactions.

8) Discovery: The user is pleased to learn new things.

9) Expression: The user is pleased to express new things and raises self-esteem.

G. Results

Each student was individually analyzed according to the model of Newman, Webb and Cochrane [16].

The result obtained by all students in the group, produced the group average. The average of all groups produced the overall result of the class.

Statistics of the overall outcome of the class in 2011 are shown in table I.

TABLE I. STATISTICS OF INTERACIONS IN 2011

Category	Average
1.Relevance	19.5%
2.Importance	18.5%
3.Novely, new info, ideas, solutions	3.25%
4.Bringing outside knowledge or experience to bear the problem	8.25%
5.Ambiguities	24.37%
6.Linking ideas, interpretation	9.37%
7.Justification	2%
8.Critical assessment	35.62%
9.Practical utility (grounding)	10.87%
Overall average considering all categories	14.63%

Each category was examined individually in each group and the results were obtained by calculating the percentage from 0 to 100 per category group. The percentage was obtained by examining the student's posts. Each student message posted was analyzed according to each category. The result was obtained by analyzing the positive factors of each category.

During the course in 2011, the teaching method proposed in this article was not used. The students were asked to evaluate and discuss the use of metaphors in websites considering no question.

Table II contains the general outcome of the interactions analysis in 2012.

TABLE II. STATISTICS OF INTERACTIONS IN 2012

Category	Average
1.Relevance	71.65%
2.Importance	58.73%
3.Novely, new info, ideas, solutions	32.86%
4.Bringing outside knowledge or experience to bear the problem	10.68%
5.Ambiguities	5.48%
6.Linking ideas, interpretation	10.27%
7.Justification	19.48%
8.Critical assessment	49.71%
9.Practical utility (grounding)	10.06%
Overall average considering all categories	29.82%

In category 1, we obtained 71.65% of relevant assertions. This result indicates that students had a significant improvement in the ability to make relevant statements. In category 2, it was obtained 58.73% of important issues. The result obtained in the category two indicates a significant improvement in addressing important issues. In the category 3, it was obtained 32.86% of new information, ideas and solutions. Students were able to propose new ideas, solutions and information. In category 4, we obtained 10.68%. Students were able to bring the information out of knowledge. In category 5, it was obtained 5.48% of ambiguities. In category 6, we obtained 10.27% of union ideas and new interpretations. In category 7, we obtained 19.48% of justification. Students were able to justify their ideas and affirmations. In category 8, we obtained 49.71% of critical assessment. The students' ability to make critical evaluations greatly improved. In category 9, we obtained 10.06% of practical utility. The average in all categories of the class of 2012 was 29.82%.

The results achieved were satisfactory. Compared with the class in 2011, class in 2012 achieved an overall gain of 15.19 percent. There was a clear improvement in all categories. In some categories there was a significant gain. Gains related to category 3 were 29.61 percent and earnings were related to category 8 of 14.09 percent. The category 1 and category 2 also greatly benefited. We note that the category 3 was the most favored. The students have acquired the ability to propose something new, new ideas and solutions, which is essential for a software engineer and interaction designer. Category 8, that is related to critical thinking, also had a great improvement.

The presented statistics show that the use of our teaching method in teaching the use of metaphors interaction design instigates and encourages any student to infer criticism and find more effective and creative solutions for the design of computational interfaces.

In tasks two and three we analyzed the products designed and presented by each group of students. In the analysis, we used the creativity checklist for website design of Zeng [12], analyzing important design factors, such as: aesthetically appealing design, interactive design, novel, and flexible design, affective design, design important, common and simple design and personalized design.

TABLE III. CREATIVITY CHECKLIST FOR WEBSITE DESIGN

Creativity Checklist	Classification
Aesthetically appealing design	Excellent
Interactive design	Good
Novel and flexible design	Good
Affective design	Good
Important design	Excellent
Common and simple design	Good
Personalized design	Excellent

The results were classified in excellent, good, regular or inappropriate. The analysis was based on the products presented by the students. Analysis of the products was successful. When making the checklist, we observed that the products obtained excellent results regarding the aesthetics. The interactive design achieved a good result. The novel and flexible design also achieved good results. The affective design which includes items such as stimulating and exciting achieved good results. The featured products have an important and relevant design; this result was excellent. In common and simple design products observed products with rare and sophisticated design. The result was classified as good. In personalized design, the result was excellent; all products owned a custom design. The results obtained in speech analysis have been confirmed in the analysis of the product. Students who possessed better performance in the categories of speech produced and presented the best products. The critics and creativity promoted by collaboration and productive interactions among students, trigged by the application of the teaching method, contributed effectively to student learning. The students applied the concepts discussed adequately. The discussions resulted in products of high quality design.

A questionnaire was developed with twelve questions to evaluate the experience gained by the students. Students who were involved in the groups that performed all the tasks proposed responded to the questionnaire. The analysis was performed according to the dimensions of UX [13].

TABLE IV. QUESTIONS ANALYSIS

Category	Average
1. Immersion and Flow	94.12%
2. Tension	85.3%
3. Competence	88.3%
4. Negative Affect	20.56%
5. Positive Affect	79.44%
6. Challenge	88.3%
7. Fellowship	50%
8. Discovery	85.3%
9. Expression	94.12%

According to the analysis 94.12% of the students forgot everything around them as they discussed the tasks. For 85.3% of the students the tension and difficulty decreased during task performance. 88.3% of students thought to be

consistent inferring opinions. 79.44% of students felt excited. 88.3% of students felt challenged and encouraged to discover new ideas and solutions. 50% of students shared good experiences during social interactions. 85.3% of students felt happy to learn new things. 94.12% felt pleasure in expressing their ideas and had self-esteem by implementing these ideas. The results obtained were very satisfactory.

The results from Table II show that we have improved the results obtained on the control group by implementing our proposed method. The results obtained from Tables III and IV corroborate the results obtained from Table II, showing that the students pleasingly engaged in collaborative tasks and successfully developed creative products.

IV. CONCLUSION

It is not known in literature the existence of a teaching method to apply metaphors in interaction design. In this paper, we highlight the use of metaphors in interaction design. The use of metaphors improves the interaction design, providing more respect and importance to computational interfaces. We addressed different types of metaphors, such as visual, functional, structural, and positional metaphor. The proper use of metaphors produces a positive and significant impact on usability of user interfaces.

However, students find it difficult to learn and apply metaphorical concepts in interaction design. In order to overcome this problem, we addressed a teaching method to teach creativity and criticism in the context of interaction design using metaphors. A case study was designed and successfully applied. The preliminary results show that the teaching method based on collaborative learning through the development of questions that stimulate group discussion achieved good results. There was a significant improvement in the class where the method was applied compared to class where there was no application of the method.

This work contributes to teachers to arouse students' creativity, directing and encouraging them to infer creative solutions and to properly criticize interaction design. This contributes greatly to their learning. In this way, any student aggregates the knowledge necessary to criticize and design a more intuitive interface that is simpler to learn and use. All students tasks were contextualized in the use of metaphors in interaction design, as can be seen in the examples previously provided. Thus, both the discourse analysis and product analysis indicates that the use of metaphors was successful.

The results show the relevance of the study and the teaching method applied. However, more case studies are being performed as well as the discourse and products analysis are being done for more than one researcher to reduce the degree of subjectivity of the research.

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