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Analysis of the development of competencies in subjects related to materials science through the software Ansys Granta EduPack® in Brazilian Portuguese

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Abstract

Theories in the educational area are constantly evolving. Learning theories, knowledge images and competencies are ideas frequently used in teaching; this is not different in engineering education curricula. Many computational resources that help education are now available, and one of them is Ansys Granta EduPack®, a tool that aids engineering students in materials selection, among other activities. Even though this may be especially useful, the language used may cause some difficulties. The influence of using this software in both languages, English and Portuguese, was investigated with two groups of students attending Metallic Materials from an undergraduate mechanical engineering course at Centro Universitário FEI. They were monitored for one semester to study the development of their competencies by using learning theories and knowledge images. This software was translated into Brazilian Portuguese and was used in laboratory classes, allowing both the analysis of the influence of the language on the development of competencies and the knowledge acquired throughout the semester. This was based on what students said, and it was noticed that the translated version has its advantages, allowing the students to focus on the assignment proposed and on the usage of the knowledge acquired, even those who are English fluent. It was also found that the use of different tools is necessary for the development of competencies.

Keywords: Competencies. Active-learning methods. Ansys Granta EduPack®.

1. Introduction

Educational theories can be used when teaching all areas, and there is no difference in engineering. Concepts present in learning theories, knowledge images and competencies are used to help teachers structure the subject, plan how they are going to teach a given topic and analyze the consequent knowledge gathered by the students.

Besides this, there are also computational simulations that are becoming more useful and present in classes daily. They approach concepts learned in classes and approximate students to real situations, aiding their development of competencies and facilitating the understanding of different topics.

In engineering, an important part of a project is the choice of materials because it affects its deadlines, cost and may impose restrictions, at times. Ashby (1989) proposed a method for this choice, in which a relationship between materials structures, properties and processing is analyzed. The software Ansys Granta EduPack® uses this methodology and the main objective is to help with this choice, but it can also be used for other purposes. Because of that, this software has been used as a tool for teaching and learning in many undergraduate engineering courses.

Even though Ansys Granta EduPack® has many advantages, its interface and information are completely in English, which can be quite challenging to students who do not have this language as a native one because they must translate all the technical terms, which may cause confusion and even delay an assignment in class when they are not used to this.

To investigate the influence of this software language in the development of competencies, skills, and attitudes of undergraduate mechanical engineering students, its basic levels were translated into Brazilian Portuguese and a group of students of the subject Metallic Materials from Centro Universitário FEI tested it, reporting their opinions afterwards. To better understand the knowledge these students had regarding materials science, all the classes of an entire semester were accompanied, and they were observed considering some knowledge images, learning theories and competencies as the theoretical background.

1.1 Knowledge images

Knowledge images are the ones that can help teachers to build knowledge, plan how to teach a certain topic and evaluate student's comprehension. Some of these images are chains, networks, maps, and icebergs (Canal USP, 2017a), which can be seen in Figure 1.

The chain image is an idea based on Descartes' book "Discourse on the Method" (Descartes, 1996). In it, three steps must be followed: start with simple concepts and make them more complex gradually, divide complex concepts into simple ones, and relate all of them in a chain (Canal USP, 2017a) and it can be seen in Figure 1(a). Therefore, knowledge can be seen in this theory as a chain in which the concepts are interconnected, as chainrings.

The network image also symbolizes the connection of concepts. In this case, nodes represent the concepts and ideas taught and the relationship between them is represented as connection lines (Canal USP, 2017b). These connections may be more or less important, their representation being with lines of different thicknesses, the more important relationships are represented as thicker lines. The teacher makes these nodes and their connections when something new is taught or by the students themselves when something new is experienced. An example may be seen in Figure 1(b).

A similar idea can be associated with another image: a map. Only the most relevant concepts are highlighted in this image, mapping out what is expected from the student to succeed and achieve a specific objective (Canal USP, 2017b), which is seen in Figure 1(c) This tool is mainly used in class planning because it helps to know to what extent some concepts will need to be explained.

The last image is an iceberg, which means that not all knowledge is seen. The whole iceberg represents the knowledge one person has, but the top of it (the observable portion) is what the person can explain, which means that what someone can express or articulate into words or sentences is only a small part of what one really knows (Chiaro, 2021). This can also be used as an evaluation tool in which students must express their knowledge to explain what they are thinking to their team or teacher. It is also important when a teacher is preparing a question in which one of the purposes is to make students remember what was taught earlier and try to make it possible for them to answer the question. An example of this knowledge image is in Figure 1(d).

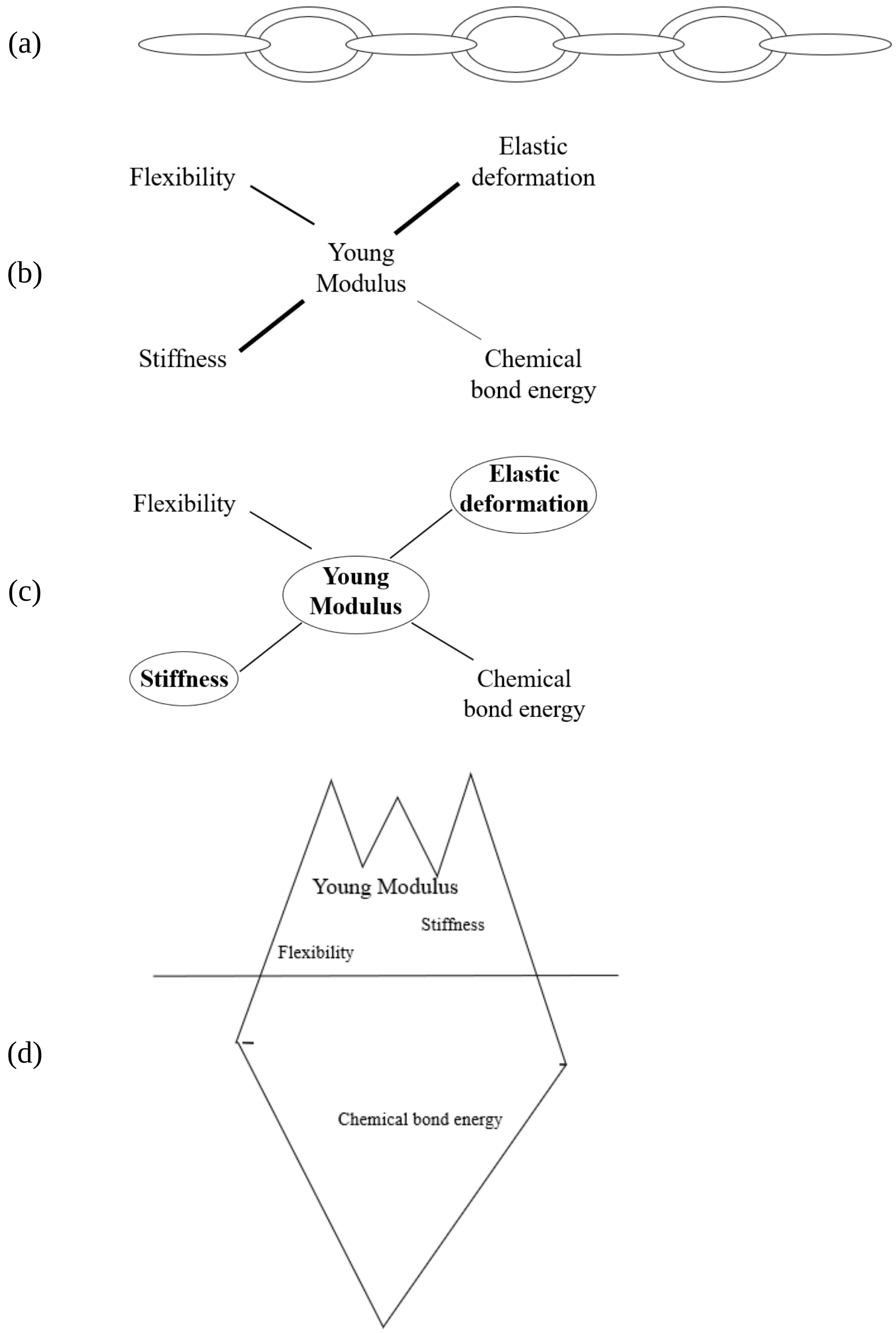

Figure 1 – Knowledge images examples: (a) chain, (b) network, (c) map and (d) iceberg.

1.2 Learning theories

According to Illeris (2013), all learning process is related to three dimensions that form a triangle and all possible situations are in its interior. In the latest decades, in Brazil, the learning theories of Constructivism, Sociocultural theory and Subsumption theory have been emphasized (Gomes et al., 2010).

Piaget’s Constructivism theory consists of the learning process through interactions and perturbations of knowledge, transforming the person into an autonomous and questioning person (Gomes et al., 2010). In it, a person may better understand a real situation by the construction and expansion of his/her knowledge, with the person assimilating the situations experienced and modifying them to adjust to his/her reality. According to Piaget, knowledge is built by the interaction between the person and the situation rather than by these factors isolated (Merlin, 2016; Sanchis and Mahfoud, 2010; Instituto Claro, 2018a).

The main author of the Sociocultural theory was Lev Vygostky who studied the learning process as the interaction between different people whose information is exchanged (Benite et al., 2009) and according to this author, knowledge takes place through continuous interaction. He developed the idea of the Zone of Proximal Development, which is the area that represents all the individual's development, ranging from the point that represents everything a person already knows to where this person can grasp with the help of someone more experienced (Instituto Claro, 2018b; Gomes et al., 2010).

David Ausubel developed the Subsumption theory. It consists of knowledge addition, in which some new information is added to what the person already knows, complementing its meaning and solidifying it. It happens when someone may absorb, interpret and make a relationship between new information and the other pieces of information this person already knows in a way that he/she may use this knowledge to solve problems and deal with different situations (Gomes et al., 2010; Santos et al., 2016). According to this theory, people are only responsible for their learning because they are "active in their learning process and can decide how to assimilate the concepts" (Santos et al., 2016).

1.3 Competencies

Perrenoud started discussing competencies in France when he realized the fragmentation of basic teaching (Canal USP, 2017c), using it as a starting point for cognitive psychology (Instituto Claro, 2020). For him, competencies involve knowing how to mobilize and apply knowledge in situations where they are not usually present (Perrenoud, 1995; Silva, 2010; Dias, 2010). In Brazil, this topic gained visibility with the first Exame Nacional do Ensino Médio (ENEM), a test similar to the SATs (Machado, 2009).

Different authors describe this concept differently; Machado (2009) points out that it depends on three fundamental axes: pessoality-integrity, mobilizing-content and scope-extrapolation or abstraction (*pessoalidade-integridade, mobilização-conteúdo* and *âmbito-extrapolação/abstração* in Brazilian Portuguese), as presented in Figure 2. They can be associated with students, teachers, professionals etc., and each of these six fundamental elements of the axes is related among themselves.

Pessoality means that only people may or may not be competent; while integrity is related to someone's ability to maintain him or herself integrated as a person and with society (Machado, 2006). In the mobilizing-content axis, mobilizing refers to knowing how to use knowledge and content in what the person knows, his/her knowledge. Finally, the scope is the necessary context for the person to be able to show he/she is competent; while extrapolation or abstraction is related to knowing how to use knowledge in a different context from the one that the person is used to.

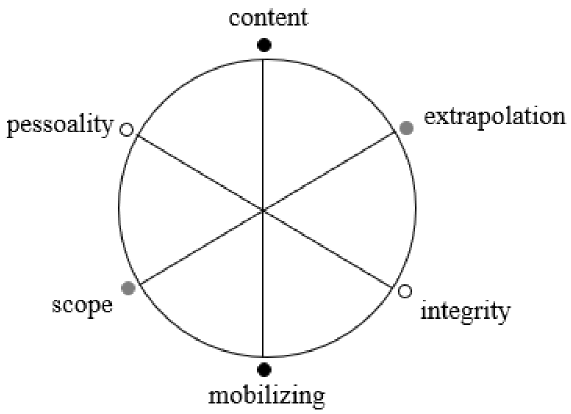

Figure 2 – Competencies fundamental axes.

For the students, the axes are expression-comprehension, imagination-contextualization, argumentation-decision (*expressão-compreensão, imaginação-contextuação* and *argumentação-decisão* in Brazilian Portuguese), as shown in Figure 3.

The expression is related to the own person, while comprehension is related to the people this person is around. Imagination is related to the capacity one must extrapolate things from concrete situations whilst contextualization is the act of understanding concrete situations. Finally, a person can decide only if one can summarize knowledge, mobilize it, and supply information for argumentation (Machado, 2009; Canal USP 2017d; 2017e).

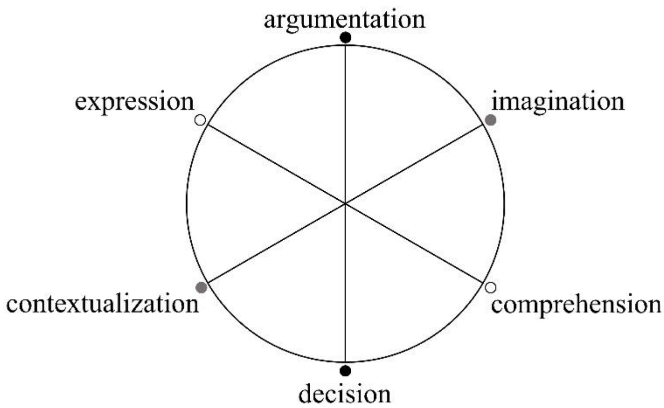

Figure 3 – Students' competencies axes.

Regarding the figure of the teacher, the axes have other names: authority-tolerance, mediation-storytelling, and sewing-mapping (*autoridade-tolerância, mediação-fabulação* and *tecedura-mapeamento* in Brazilian Portuguese), as represented in Figure 4.

Sewing represents the ability a teacher must have of creating a story that relates to the concepts being taught while mapping refers to the establishment of the level of relevance between concepts and their relationships. Mediation is related to the bridge a teacher is supposed to create between the interests of his/her students and what is being taught whilst storytelling is the act of telling stories that have a meaning to what is not concrete. Authority is the ability to create critical thinking in students and tolerance is related to considering a person's reaction when exercising this authority (Machado, 2009; Canal USP 2017c; 2017f).

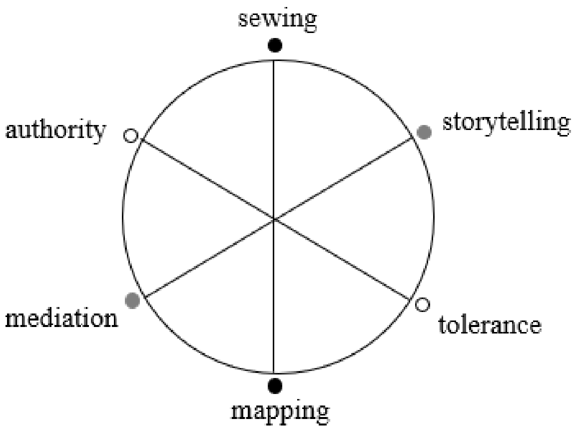

Figure 4 – Teachers' competencies axes.

2. Methods

Ansys Granta EduPack® software levels 1 and 2 were translated into Brazilian Portuguese, with two revisions being made before sending the translated texts to the responsible company. This translation was done by consulting technical articles, websites, books, and professionals of specific areas. After one of the researchers provided the translation tasks, the other one reviewed and revised all the texts and some terms were discussed to find the best translation for it. Then, a second revision was made, and a software beta version was sent by the company responsible for it.

During one semester, all laboratory and theoretical classes of the Metallic Materials course of an undergraduate mechanical engineering curriculum from the Centro Universitário FEI were followed closely by one of the authors of this paper. The theoretical classes consisted of about forty students, while the laboratory ones had about twenty because the facility is smaller. Their behaviour and opinions were analyzed through observation and conversation during these classes and a questionnaire was made at the end of the semester to understand the students' opinions more deeply, available in the appendix. All analyses were guided by the knowledge images, learning theories and competencies concepts.

For the analysis of the development of competencies, the qualitative approach was chosen because the opinions, behaviours and attitudes of the objects of study (students), were more important than the statistics that can be associated with them and the number of people studied in this research. Bogdan e Biklen (1998) affirmed that this analysis involves the apprehension of descriptive data through direct contact between the researcher and the object of study, emphasizing this process and relating to the perspective of study objects.

According to Lüdke and André (2020), with this chosen type of approach, observation is one of the main tools that can be used. This allows a closer relationship between the researcher and the object of study, which leads to several advantages. The perspective of the students is the main aspect the researcher tries to comprehend, to understand their point of view of the studied situations, and the reflections of the observer about this perspective are also particularly important. Besides these advantages, observation also allows the collection of information in situations where the object of study can not or does not want to give any information.

Different methods of observation depend on the degree of participation of the observer, the researcher's explanation of the purpose of his/her presence in the environment and the explanation of the research objectives. The chosen method was the *observer-as-participant approach*, where the students knew the observer's identity and her purpose in the classroom from the beginning of the semester (Lüdke and André, 2020). This method was chosen because it allowed the researcher to access different pieces of information only by asking for the students' cooperation, i.e., their answers in the questionnaire and conversations.

The methodology in class consisted of games, challenges, and tests throughout the semester. These games had ten questions at the beginning of every theoretical class, concerning topics that had been explored a week earlier, with a ranking of the students with the best scores being made and the teacher discussed the questions with more frequent errors. Time was not involved in this ranking. This game took around 5 minutes, and it was used as an ice breaker. Then the class started, with the concepts being taught, sometimes using videos and other useful tools such as lectures, exercises, and simulations in Python. At the end of it, the teacher solved a challenge with the new ideas learned, similar to what would be proposed after class using a specific platform, Moodle. Students would have to form groups to solve a challenge investigating the competencies involved in the specific topic explored in class.

This challenge was proposed almost every week for the students to solve in groups chosen by the teacher: a problem was proposed in which some conditions were imposed (mechanical properties, microstructures etc.) and the team members would have to discuss the processing route to achieve these goals. After this, they would have to create a document with a possible solution and a diary expressing what each member did to solve the challenge. One example was the challenge in which the diameter of a rod of material was given, together with some graphs that represented the mechanical properties of different materials such as elongation, tensile strength, and yield strength versus the degree of cold work. The objective was that the students thought about a way of achieving both a specific final diameter of rods and their mechanical properties. All the necessary data were supplied so that the students had to find the best way of achieving those objectives, i.e., the expected yield strength, tensile strength, and ductility (strain). Besides these tools, in the middle of the semester, a test was given as well as by the end of it.

As for the laboratory classes, not all the students were present throughout the semester, but that did not pose a problem in our investigation because our research was based on interviews with a qualitative view, i.e., the perceptions of some students were important in a certain period; in this case, the whole semester. At the beginning of each class, the teacher reminded his students of the important theoretical details that would be necessary to do the experiment in the lab, then allowed the students to do it. Throughout the semester, some online quizzes were assigned to the students using Moodle platform. These quizzes explored the practical aspects of materials processing and its consequence on the mechanical properties and microstructures of these materials.

After 10 weeks, the topic materials selection was finally investigated in both theoretical and laboratory classes. It was only then that students had the opportunity to use the translated version in Portuguese of Ansys Granta EduPack software®.

3. Results and Discussion

For the analysis of the development of the competence axis proposed by Machado (2009) and the use of knowledge images and teaching theories, the Syllabus was used as a guide to find what the study parameters would be. This document was elaborated by the teacher and was available the whole semester on Moodle platform. In it, the objectives, methodology, weekly teaching timeline, evaluation tools, students' assignments and bibliography were given in detail. For this research, the development of competencies presented in Table 1 with their definitions, found on the Syllabus, were analyzed throughout the semester using the theories already presented as a theoretical background. These were taken from the pedagogical project of the mechanical engineering course, widely available for the whole community.

Table 1 – Competencies analyzed.

Competence name	Competence description
C-04	Ability to work on and lead multidisciplinary teams, interact with people with multiple cultures and be able to comprehend, respect and value their differences.
C-05	Ability to efficiently communicate orally, written through graphs and images.
C-07	Analysis and comprehension of physical and chemical phenomena through mathematical, computational and physical models validated by experimentation.
C-09	Ability to create, project and analyze systems, products, components, or processes in mechanical engineering.
C-11	Creation, identification, validation, and application of models for optimization and problem solutions in mechanical engineering.
C-12	Ability to use natural, energy, technical, and human resources efficiently considering sustainable issues.

Besides the answers to students' questionnaire, the development of these competencies was evaluated by observation using knowledge images, learning theories and competencies concepts developed by Machado (2009) and by the opinions heard throughout the semester, leading to the conclusion that all of them were well developed. They are explored in more depth below.

Competence C-04 is related to the students' axis expression-comprehension from Machado's theory because it consists of the interaction between the person, the expression side of the axis, and the others, the comprehension side. Some students complained about some of the proposed activities, which were made in a group chosen by the teacher, but it was observed that in general they were well developed because the teams were able to organize themselves and communicate solving different challenges, leading to the conclusion that competence C-04 and the student competence axis were well developed. However, there seems to be room for improvement here: one possibility is to give students the power to choose their peers to form their teams and another is to continue the development of the activities this way to stimulate the interaction between them.

Matta, Luce & Ciavarro (2011) affirmed that "building diverse teams is both important to the success of the teams, as well as the simulation of 'real world' problems that students may encounter outside of the classroom". Another advantage is the fact that a group formed by people with different visions of the world is more likely to have more solutions to a problem because each person will bring a different point of view to the discussion (Maznevski, 1994, apud Matta, Luce & Ciavarro, 2011). The approach of not allowing the students to choose the challenges teams was better in this case because competence C-04 is all about diverse teams and it was noted from early situations that when the students were allowed to make this choice, there was a tendency for the same teams or similar ones being formed regularly, which may jeopardize the development of competence C-04.

The development of competency to work in teams was also observed in our laboratory classes where the student had to work in groups to achieve different aims, depending on the topic worked on in class. A simple example is when one student was responsible for using the microscope, which means handling the specimen, focusing the image and sharing it with another student using a specific image analyzer installed in a computer dedicated to this microscope. The images had to be collected and shared with others by uploading them to Moodle platform. Another student had to measure the specimens' hardness or determine specific tensile properties such as elongation, yield strength, tensile strength, resilience, and toughness, and tried to correlate these mechanical properties with the specimens' microstructures and the processing they performed (for example, the rolling of a copper sheet). During the experiments, the class made several observations when seeing the results gathered, complementing one another multiple times. It is worth mentioning that all laboratory classes had to be carefully planned with the help of a technician for these to be successful.

The development of competence C-05 was also noticed, demonstrating the effectiveness of the iceberg knowledge image as a way of evaluating the students because they were capable to express all knowledge acquired during the semester proposed in the tests, challenges and quizzes. Considering the student competence axes of Machado (2009), the student axis argumentation-decision was clearly observed because the mobilization of knowledge is important to analyze it and express it as required by competence C-05.

This competence was also observed in the challenges proposed by the teacher because all types of communication were necessary for the teams to create a plan to solve the problem and explain it to the teacher. Besides that, every time a question was asked in class, the students' communication skills were evaluated and characterized.

Competence C-07 is related to the teacher competencies axes sewing-mapping and mediation-storytelling. These axes were well developed because it was noted by the researcher that concepts taught were understood by the students, creating the network image as well as the map image. Other than that, this competence also showed that the bridge between the student and the knowledge was built, which means that the teacher was able to help his students to develop their potential knowledge, going through the Zone of Proximal Development (ZPD) from Sociocultural theory.

The observation of C-07 occurred both in the laboratory and theoretical classes, the concepts and ideas related to material science were explained in the theoretical classes and after at least one week, they were applied in parts of the experiments, requiring that the student remembered them to understand what was being done.

One example of the development of this competence was when the students learnt about phase diagrams and phase transformations in theoretical classes. Just a few days later, an experiment involving samples with the same chemical compositions was done. These samples were put in furnaces at different temperatures and after a certain period, their microstructures were analyzed. Knowing the temperatures used and observing the phase diagram for that alloy, students were able to identify the phases that should be present and calculate their quantities (e.g., area fraction). Even though the concepts related to phase diagrams and phase transformations were taught earlier, it became clear by their expressions, behavior, questions and observations that the ideas learned were absorbed in a much better way than without the experiment, allowing them to relate much better to key concepts.

This moment and many others similar to it made it clear that the map and network images were being created because the relationship between the concepts got clearer for the students (network image) and they were able to understand which of them was/were more important in the situation studied (map image). Moments like this also demonstrated that the teacher was able to create a relationship between the concepts from the theoretical classes, with different degrees of importance, connecting the students and their knowledge, developing the axes sewing-mapping and mediation-storytelling.

For competence C-09, the students' axes imagination-contextualization and argumentation-decision from the students' competencies were present because this competence involves the creation, projection and analysis of systems, products, components, or processes. To create a project, it is necessary to have the ability of abstraction, which requires the ability to mobilize all the knowledge acquired and analyze it.

Competence C-09 was mainly observed and developed during the challenges and the laboratory experiments. In the experiments, students needed to follow the steps of a process to achieve an objective; they observed the results obtained and drew conclusions and assumptions throughout the process. This was observed in almost all classes where they made comments about what they thought was going to happen and what really happened.

One example is the experiment of the annealing process where students used three samples of copper of commercial purity. They were put in different furnaces with different annealing temperatures and left there for the same amount of time. After it, the samples were quenched and a tensile test, hardness measurements and microstructure observation were done. After evaluating their hardness, a student guessed whether the following sample would be harder thanks to a higher annealing temperature. Even though the student was not right, this example clearly demonstrates the development of competence C-09 because after following all the necessary steps for the annealing process, the student drew a conclusion based on what he/she remembered from theoretical classes and after finding out the real result, the teacher explained again the theory needed for that experiment, allowing him/her to completely comprehend the concepts.

The development of projects took place during the challenges because, knowing the objective, the students were able to create a path to be followed, testing and proving their theories. Most of the time they succeeded, which demonstrates that this competence and all things attached to them were well developed.

Besides this, competence C-09 was also observed with the use of the software Ansys Granta EduPack® because after the theoretical classes, the students were able to work on micro-projects (also called case studies) involving materials selection, mechanical, physical and chemical properties. In one of these projects, the students had to choose a metal or a metallic alloy that had a grain size that allowed a certain diameter reduction while achieving some mechanical properties and going through a certain annealing treatment.

In Ashby's methodology, materials' properties can be related in pairs in a map where each axis represent one of the properties, as in Figure 5 that relates the Young Modulus of materials and their density, which may also be found in his original article "On the Engineering Properties of Materials" (1989). The software Ansys Granta EduPack® allows the creation of these maps, seen in Figure 5; therefore, during its use, students had to remember the wanted properties and translated them into Portuguese if the software was in English, to be able to filter all materials available according to the necessary characteristics until they found the best material for this specific situation.

Competence C-11 exercised the same axes as competence C-09 (imagination-contextualization and argumentation-decision) because the creation of models and solutions involved in this competence needs the ability to mobilize all the necessary resources. This competence was mainly observed during the challenges because these were the circumstances in which problems commonly found in mechanical engineering were presented to the students, and they had the autonomy to propose a solution or any method they thought could solve the problem. Even though the objective was not always achieved, students were required to mobilize all their knowledge to do this, which is why the researcher considered that competence C-11 was developed.

The last competence observed on the subject was C-12. It involves the images of chain and map because it requires students to remember and use information heard and learnt in other places to employ resources sustainably during the solution of some challenges, for example.

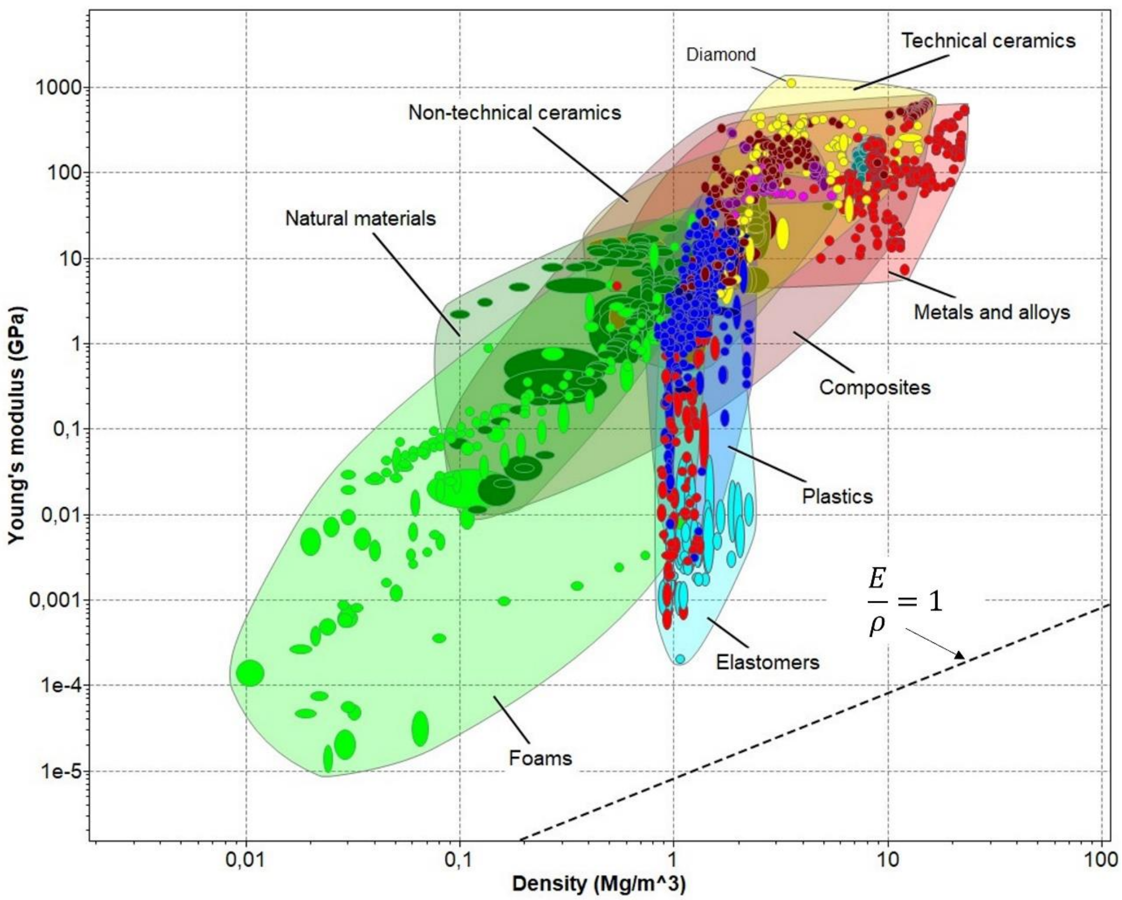

Figure 5 – Example of a map using Ashby's method (ANSYS, 2021).

In all engineering projects, it is important to use natural, energy, technical, and human resources with minimum impact on the environment. This is why students exercised this competence when developing the challenges. In the third proposed case study, this competence was clearly observed because in it the objective was to choose a material with certain mechanical properties that minimized both the carbon footprint and energy used in the chosen material production.

Another important concept that was observed during the challenges were the Constructivism theory because knowledge gathered in it requires that the student ask themselves how to solve the proposed problem. The Sociocultural theory was also present because of the interaction between the random groups, stimulating relationships outside the student's comfort zone. Lastly, the Subsumption theory was observed because to solve the challenges, students must be responsible for their learning, they must search for other sources of knowledge outside the classroom. Some of them used their textbooks or the web whilst others talked to each other to find the best solution.

During the use of the software Ansys Granta EduPack®, the same knowledge images from the challenges are exercised because the students had to know the important concepts that needed to be evaluated, creating relationships between the concepts to choose the best material for some situations. If the objective were to choose the material with the highest tensile strength after a rolling process, for example, the students had to remember that during this process the more hard worked the sample, the bigger the density of dislocations, resulting in a microstructure with elongated grains and higher mechanical properties such as yield and tensile strength.

The main learning theory observed is the Constructivism theory because without the questions the students make themselves, the software can not help them. When the software was used, students were in the classroom allowing them to communicate and help each other as is mentioned in Vytotsky's theory.

When asked about its use, one student claimed that there were too many options in the software, making its use difficult. A second student agreed with this, saying that at first, it was confusing, but over time he got used to it. Some other students affirmed that it was not hard to use, but "the lack of translation may have interfered in the personal development" and that the main difficulty was the translation of the technical terms and their meanings.

That showed there was ambiguity among students' opinions about the software because while some thought its interface and manipulation were the hardest and most confusing part; others did not have any problem with it. Even though this was not in the project scope, this information allowed the conclusion that for each person the experience of using the software is different, therefore the qualitative approach chosen for the project was the best choice because by adopting it, the researcher was able to comprehend better the student's opinions as a single person and not as a group of people that share the same viewpoint.

Besides the opinions already presented, another student claimed that the software in English has some advantages as the study of the language itself applied to Engineering and the fact that some translations are not as precise as the original language, but the very same person mentioned that the Portuguese version is better because it allows the students to focus on the assignment proposed rather than dedicate his/her attention between the translation and the assignment.

Considering the gathered opinions, it is possible to conclude that the translation of the software Ansys Granta EduPack® has achieved its objective, helping our students to develop the assignment without having to share their attention with the translation of terms. From what was observed, the Brazilian Portuguese version aids the students that are having their first contact with materials science to better associate the technical concepts taught in their mother language without having to worry about wrong translations that happen frequently when they use the English version.

4. Conclusions

Through the monitoring of the class during one semester, it was possible to observe that the competence axes proposed by Machado (2009), for the student and the teacher, were greatly exercised with the great development of the competencies proposed in the Syllabus of the Metallic Materials course, but there is still room for improvement in all of them. The teaching theories and knowledge images were also effective because they helped in the Syllabus creation, in the teaching of the concepts and the development of the competencies.

The translation of the software Ansys Granta EduPack® resulted in ambiguous opinions because some of the students mentioned that the software use was easy, and others thought it was confusing and difficult. Even though there was disagreement on the software's ease of use, the students agreed that using it in their native language helped them to focus on the assignment proposed and not on the translation and interpretation of terms, even for those students who are fluent in English. This leads to the conclusion that the translation of the software Ansys Granta EduPack® has achieved its objective, helping the students to understand the software better, associate the terms learnt in theoretical classes and develop projects applying these same concepts, i.e., to understand Ashby's logic and methodology.

By solving challenges and using that software, the knowledge figures, learning theories and competencies axis were extremely present because the creation of the knowledge was necessary, with the creation of relationships between the different concepts taught and the identification of the most important ones in each situation. The mobilization, analysis, and communication of the knowledge gathered were also necessary as well as the interaction between different people with different opinions because students were able to solve the problems proposed in teams with people they were not close to.

The development of the competencies proposed on the subject Syllabus (C-04, C-05, C-07, C-09, C-11 and C-12) was observed multiple times throughout the semester. In theoretical classes, they were observed mainly during the challenges, where a mix of all the theories presented was usually seen, but during the laboratory classes, they were easily observed because at this moment, the number of students was smaller and the contact between the observer and the students was closer.

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Appendix

Questions	Type of answers	Possible answers
1- Have you read the Syllabus of the Metallic Materials subject?	Multiple choice	Yes No
2- How much do you believe you developed the competence C-04 (Ability to work on and lead multidisciplinary teams, interact with people with multiple cultures and be able to comprehend, respect and value their differences)? *	Likert scale	Ranging from 1 (I did not develop it) to 10 (I developed it completely)
3 - How much do you believe you developed the competence C-05 (Ability to efficiently communicate orally, written through graphs and images)? *	Likert scale	Ranging from 1 (I did not develop it) to 10 (I developed it completely)
4- How much do you believe you developed the competence C-07 (Analysis and comprehension of physical and chemical phenomena through mathematical, computational and physical models validated by experimentation)? *	Likert scale	Ranging from 1 (I did not develop it) to 10 (I developed it completely)
5- How much do you believe you developed the competence C-09 (Ability to create, project and analyze systems, products, components, or processes in mechanical engineering)? *	Likert scale	Ranging from 1 (I did not develop it) to 10 (I developed it completely)
6- How much do you believe you developed the competence C-11 (Creation, identification, validation, and application of models for optimization and problem solutions in mechanical engineering)? *	Likert scale	Ranging from 1 (I did not develop it) to 10 (I developed it completely)

continue

* Compulsory questions.

Questions	Type of answers	Possible answers
7- How much do you believe you developed the competence C-12 (Ability to use natural, energy, technical, and human resources efficiently considering sustainable issues)? *	Likert scale	Ranging from 1 (I did not develop it) to 10 (I developed it completely)
8- In case you do not believe you have developed one or more of these competencies, what do you think could be done to help a student to develop it?	Essay questions	-
9- In case you believe you have developed these competencies, is there anything you think could be done to help a student to develop them more easily?	Essay questions	-
10- Did you know or have used Ansys Granta EduPack© software? *	Multiple choice	Yes No
11- What were your general impressions of this software (hard or easy to use, intuitive, or confusing etc.)? *	Essay questions	-
12- In case you have already used it, what were your impressions of this English version?	Essay questions	-
13- What were your impressions of the Brazilian Portuguese version of Ansys Granta EduPack© software? *	Essay questions	-
14- How important do you think the native language being the one used is? *	Likert scale	Ranging from 1 (I did not develop it) to 10 (I developed it completely)
15- How important do you think how intuitive the software is? *	Likert scale	Ranging from 1 (I did not develop it) to 10 (I developed it completely)
16- How important do you think the specific packages are? *	Likert scale	Ranging from 1 (I did not develop it) to 10 (I developed it completely)

continue

* Compulsory questions.

Questions	Type of answers	Possible answers
17- In case you have any other comments about Ansys Granta EduPack© software, please write them here!	Essay questions	-
18- Do you like the engineering course, in general? *	Likert scale	Ranging from 1 (I do not like it) to 10 (I like it completely)
19- If you wish, write a comment about the last question here.	Essay questions	-
20- What is your opinion about the Metallic Materials subject? *	Essay questions	-
21- Do you understand the concepts taught on the Metallic Materials subject? *	Likert scale	Ranging from 1 (I do not understand them at all) to 10 (I fully understand them)
22- If you wish, write a comment about the last question here.	Essay questions	-
23- How do you study? *	Options	I use the available material. I read the previous-to-class material. In a study group with my colleagues. I usually study alone I watch classes. Others.
24- If you wish, write a comment about the last question here.	Essay questions	-
25- How would you describe your relationship with your colleagues? *	Essay questions	-
26- Is there anything you believe would make your learning easier?	Essay questions	-

continue

* Compulsory questions.

Questions	Type of answers	Possible answers
27- What is your opinion about the games and the dynamics used on the Metallic Materials subject?	Essay questions	-
28- If there are any other comments you like to make about the subject, please write them here!	Essay questions	-