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ERGONOMICS TEACHING AND DESIGN: EXPERIENCES OF APPLYING A DYNAMIC WORKSPACE DESIGN

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Abstract: The current context of teaching ergonomics and design in higher education courses presents a series of challenges to the teacher: on the one hand there is the apparent distance between the conceptual discussions, subjective, inherent in the field of ergonomics and the recurring practical characteristic to the discipline of project; on the other, the great diversity of areas of training and interests of students can lead to misunderstanding the real importance of the area of ergonomics and design, possibly leading to lack of interest on the part of students. The present work presents the development of a work space design dynamics and the experiences derived from its application in the context of the teaching of the methodology of the Ergonomic Analysis of Work and the project of improvement subsequent to the analysis. The presented dynamics managed to articulate the concepts relevant to the theme, bringing theory and practice closer together and promoting a greater engagement of students in the learning process.

Keywords: ergonomics, work design, teaching, play, dynamics

1. INTRODUCTION

Teaching Ergonomics and Work Design subjects, in higher-level and specialization courses, is challenging for several aspects, highlighting the theoretical and practical distance in which these areas were developed; while theory in the field of ergonomics is guided by subjective conceptual discussions, practice requires objectivity and experimentation. In addition to this obstacle, it is a fact that undergraduate and postgraduate students from courses that have these fields of knowledge in their pedagogical projects (especially Production Engineering) have interests in specific areas, sometimes distant from those, such as Quality, Planning and Control of Production, Operational Research and even Economics, resulting in a lack of interest and misunderstanding of the real importance of the areas of Ergonomics and Work Design on the part of students

Another challenging aspect is present more frequently in specialization courses in ergonomics and is directly related to the plurality of undergraduate training that exists in the training of those interested in working as an ergonomist. There is a vast presence of professionals in areas associated with health, such as physiotherapy, occupational therapy and nursing; On the other hand, these courses also include professionals with training closer to the project context, such as engineers and architects, many of whom come from areas such as occupational safety. The diversity of training observed potentially brings a wealth of multidisciplinary views on the object of study, however communication between professionals with such different logics is challenging, with the teacher having the role of mediation and development of intermediate and border objects that can support the teaching process and classroom discussion. The initial training of students is, in general,

determinant for their posture and main concern when they are faced with ergonomic intervention situations; while engineers tend to focus on the technical and productive aspects of the problem, healthcare professionals emphasize the physical and biomechanical issues related to the operator. Overcoming this initial predisposition is fundamental to the training of a complete ergonomics professional, who is concerned both with the technical and productivity aspects of the system, as well as with issues of health, well-being and safety of workers.

These facts can reduce students' interest and involvement in the content and importance of the ergonomics project, making it a challenge for the teacher to seek new forms and dynamics of teaching that will involve them in the process of learning concepts and practicing skills. analysis and design of work. For students, such dynamics can be an opportunity to deepen their knowledge and, eventually, carry out a group project (practice) in a monitored manner.

This context motivates this work to discuss and share experiences related to the development and application of a classroom dynamic designed with the aim of presenting and consolidating topics related to Ergonomic Work Analysis (AET) and engineering design in different contexts and target audiences, motivating them to better study the topic and making efforts to bring theory closer to ergonomic practice.

2. THEORETICAL FRAMEWORK

The dynamics developed had as its main guide the teaching and learning process of a classic Activity Ergonomics methodology, AET and theoretical and practical concepts of engineering project. Thus, the theoretical framework addresses these three fields of knowledge/action.

2.1 Ergonomics and Ergonomic Work Analysis

From the perspective of Ergonomics centered on Activity, Ergonomic Work Analysis was systematized in several stages to understand and transform work, however, as explained by Jackson Filho (2004), AET is a methodology that seeks to reflect and address reality of work and not prescriptions for methods or techniques. For Wisner (1994), AET comprises five stages, to which the author attributes different levels of difficulty and importance, namely: Analysis of demand and contract proposal; Analysis of the technical, economic and social environment; Analysis of activities and work situation and return of results; Ergonomic recommendations and Validation of the intervention and efficiency of the recommendations.

For Wisner (1994), the analysis of activity and work situations constitutes the essence of the ergonomist's work; At this stage, behaviors are observed and their determinants are explained. This stage has three central objectives: the preparation of a (non-exhaustive) inventory of human activities at work; identification of the main interrelationships between activities; and, description of the work in its entirety. The author indicates that at this stage not only action gestures are studied, but also communication and observation gestures, constituting a realistic analysis in contrast to movement studies recommended in other approaches. Finally, AET also comprises a stage of developing ergonomic recommendations so that a new work situation can be effectively designed (WISNER, 1994).

2.2 Engineering Design and Work Design

Pahl et al. (2005) state that the engineer's mission is to find solutions to technical problems. To do this, it must be based on knowledge from natural sciences and engineering, considering material, technological and economic constraints, as well as legal, environmental restrictions and those imposed by human beings. For the authors, problems become concrete tasks when, to solve them, engineers have to create a new product (artifact). Complementing these authors, one can also add the modification of a process or environment seeking to improve its use for the intended purpose.

The engineering project, for Bucciarelli (1988), can be understood as a social process. Such a definition is broader than the understanding of the project being the result of the work of a team of experts. The author, in his research, understands that participants in the design process act with different responsibilities, perspectives, interests and technical skills, defining what he called the object world, and that at the same time, they share certain models and objectives.

The discussion that we intend to address in this article has as its locus the world of work. Therefore, the discussion of the engineering design concept must be focused on the work design. Barnes (1977) presents the terms “work design” and “work study” as suggestions to be used in place of “motion and time study” (EMT). One of the main logics that permeates, and at the same time limits, the TMS approach is that of economy of movement and reduction of fatigue. Thus, much of what is presented works to facilitate and save workers' efforts, including the issue of the time needed to recover from fatigue.

On the other hand, it is avoided as much as possible to consider the variability of the subjects (with few exceptions, such as anthropometry), their psycho-physiological characteristics and individual preferences. This approach, which ignores activity according to the concept developed by situated ergonomics, is still dominant in work design and production management books, as can be seen in Slack et al. (2009) – a recurring reference in pedagogical projects in Production Engineering. Therefore, incorporating the activity into the work project is urgent and increasingly necessary, hence the challenge of better teaching it, in practice, to students.

2.3 **Teaching Ergonomics and Design in Engineering**

Engineering education is strongly based on the formal approach of the educational system (DIB, 1988). It appears that the relationships between teacher (master), student (apprentice) and institution are constructed in such a way that the greatest focus and responsibility for teaching falls solely and exclusively on the teacher, as he is the authority, supposedly, holder of all relevant knowledge within the classroom. According to Belhot (2005), the emphasis given to aspects related to the definition of the curricular structure, assessment methods and programmatic content is recurrent in this traditional approach, materialized by a routine composed of well-defined steps, which must be memorized by students and applied in solving of specific problems, generally defined and structured. In this scenario, the distancing of teaching-learning from the unstable and unpredictable real world becomes evident, so that students' training is insufficient to deal with the specificities and variability inherent to reality, as Freire (2001) points out.

On the other hand, analyzing in more detail the potential role of the student in the acquisition of knowledge, there are currently several theories and learning models that aim to identify the influence that the personal characteristics of each student (such as personality, tastes, facilities) have on their apprenticeship. Now, since students are not considered as a homogeneous mass, which responds uniformly to the teaching strategies applied by the teacher, it is necessary to develop new approaches and diversify existing ones so that greater involvement and practical participation can be obtained. in the collective construction of the act of learning.

The presence of technology reinforces this current situation by changing the role of the teacher, from a representative of knowledge, to its mediator and instigator. As Prensky (2001) highlights, the new generations are digital natives, since since childhood they have been in constant contact with the most varied devices and electronic games in addition to having access to practically unlimited information. It is noted that students in this profile are increasingly refractory to traditional forms of teaching that require their passivity.

In this context, the search for new teaching strategies is fundamental and concepts from the field of study of human-computer interaction, more specifically those related to game development, become relevant in this journey. Gee (2005). presents a series of fundamental principles that are, to a greater or lesser extent, addressed and worked on by game designers, analyzing them from the perspective and logic of using the game as a teaching tool. These principles, such as, for example, the principle of agency (where the student becomes an agent of their own knowledge, ceasing to be passive) and the principle of feedback (which allow the player to receive feedback on their strategies and performance, enabling their development), are crucial for creating a meaningful game experience for learning, which, in general, presupposes that the designers have effectively managed to convey their “message” to the player, or even “teach” some concept or aspect of a given subject. relevant to the training of the student-player. These principles, when applied in situations other than games, constitute a gamification situation (WERBACH; HUNTER, 2012).

3. MATERIALS AND METHODS

In the context of the Ergonomics discipline, one of the fundamental topics that must be covered with students is the AET methodology. The theoretical discussion of the topic is usually carried out in the classroom at different times, which is strongly guided by the theoretical developments brought by Guérin et al (2001). Assessment of students' learning regarding the topic is commonly carried out through an essay assessment (individual test) and practical work in a company (group project).

Seeking a greater proximity and relationship between theory and practice, the main author of this article developed a dynamic - and the other authors participated in its application - that supported the teaching and learning of concepts related to AET and engineering design, adapting an experience real professional of ergonomic intervention in which he was involved.

4.

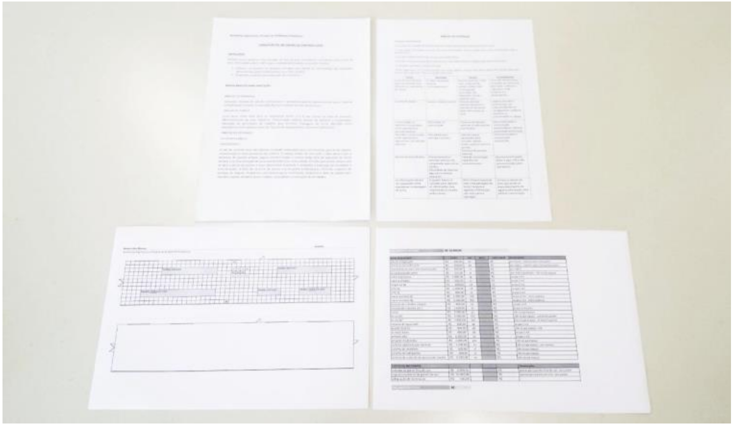
3.1 – The Dynamic: Development and Format

The dynamics developed aimed to simulate the performance of an ergonomist in the analysis and design of a local control room in an energy sector in a large continuous process industry. Participants receive a summary of a report with the main topics covered in AET (with emphasis on Demand Analysis, Task Analysis, Activity Analysis and Diagnosis). To understand the activity, some verbalizations are presented and a table with different situations where the conditions and determinants of the real work in the aforementioned control room are made explicit.

Another material made available to students is a template representing the current layout of the control room and just below a “blank” template that should be used for the analysis and design process. Finally, a spreadsheet is delivered containing the maximum budget available for the intervention, all available items (a total of 25 options, including workstations, tables and dividers), individual cost of the items and a brief explanation of the space required and/or other important observations. Some structural renovation options and their costs are also presented, such as changes to control panels and lighting adjustments. This described material is illustrated in Figure 1.

After presenting how the dynamics work, the professor explains the initial demand that was placed by the sector's workers, comments on how the AET was carried out by the ergonomics team and highlights the diagnosis constructed. From this point on, the groups must read the material carefully and begin the design phase, considering the constraints and determinants observed in the real work situation, the technical/technological options and the associated costs limited to a predefined maximum budget.

Figure 1 - Material given to students to carry out the dynamics.



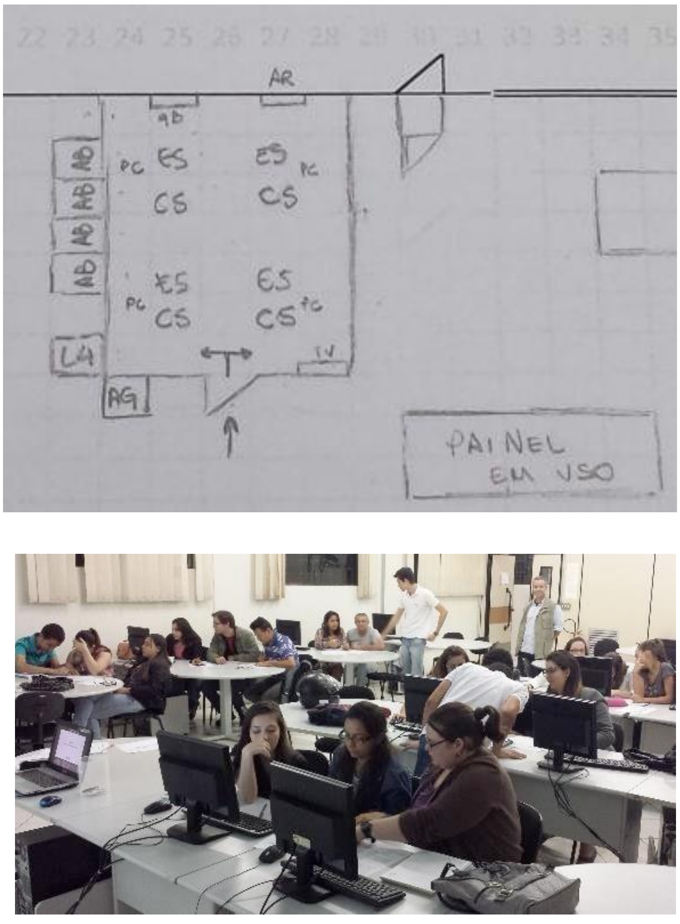
The result of the dynamics must be expressed in two documents: the layout project on the template and the spreadsheet of items with the quantity of each one that the working group chose to purchase/implement. These documents are delivered to the dynamics applicators (teacher and monitors) so that they can make two assessments: a quantitative one (based on the spreadsheet) and a qualitative one (based on the designed layout). Both analyzes are incorporated into a summary spreadsheet that contains the tables of each group and automatically calculates the score obtained by the teams to give an idea of how much the proposed solution responds to the initial demand (and the AET presented) through a design process. engineering (simplified). The score related to each project item was assigned by the developer according to their real experience in how each solution met the needs of the site's workers and the expectations of the responsible management. As a form of encouragement, following the concept of gamification, the ranking of teams and the winners of the round and/or game are defined in a summary spreadsheet that is presented to participants at the end of each round.

3.2 – The Dynamics: Applications

With small changes, the dynamic has so far been applied in four different situations. The first two were in the context of the Ergonomics discipline for fourth-year Production Engineering graduates in the first semester of 2014. The third application took place as a workshop for students of the business emphasis of the Library and Information Science course (third year) in second semester of 2014. And the last application, which took place in the first semester of 2015, targeted students specializing (postgraduate) in Ergonomics.

The main differences between the applications were in terms of environment, different profile of each course, use of an electronic spreadsheet and adoption of a round system with intermediate scores. In the first two, the dynamics took place in the classroom and with the exclusive use of sheets of paper by the students (around 70 people). The third took place in a specific laboratory for group work, with computer support from electronic spreadsheets for students (approximately 20 students) and with the support of two monitors. The last application took place in a conventional classroom (around 20 students), using sheets of paper, but with freedom to use portable computers and other mobile devices (however, no files were made available to students). In Figure 2 it is possible to observe one of the applications carried out and, as an example, a proposed solution developed by one of the teams.

Figure 2 – Photo of the application of the dynamics and part of the solution proposal presented by a team of students



Source: Authors

4 RESULTS AND DISCUSSION

Competition seen from a healthy perspective like a game is an important factor for engagement. It can be clearly seen that when competing groups seek the best possible result based on the guidelines provided for carrying out the dynamic. On the other hand, members of the same group need to collaborate and actually work as a team, discussing alternatives and reaching a consensus that is consolidated in the draft proposal. Furthermore, the project process begins to demarcate roles among the group's agents: there are those who are more busy with the budget, marking a position in this regard, others manage the time and order of project matters, others are busy understanding further the synthesis of the AET provided and so on; however, everyone collaborates to design the best possible technical solution for their group.

It is important for teachers to manage time and conflicts; Time is a factor that varies depending on the class's involvement and the number of application rounds. Students, once engaged, end up developing a certain excitement about the exercise, which can lead to longer periods of activity (they often explain that they would like more time to think about solutions). However, actually simulating a real scenario, time is scarce, deadlines need to be met and students need to learn to manage it.

The use of electronic spreadsheets by students greatly helped in saving time for calculating expenses, creating different proposals (scenarios that the team created to discuss, compare and analyze) and, finally, facilitating the evaluation process of applicators , but not eliminating it completely, given the need for qualitative consideration of the layout.

The main conflicts observed derived from the interpretations that each group of students constructed about the score. At first, this interpretation tends to be a bit problematic on the part of participants who may question the logic of the score. In applications that relied on the round system, there was a significant reduction in this problem, with maturity taking place around scoring and understanding the game and causing the project to evolve in order to incorporate determining aspects of the activity into the solution.

5 CONCLUSION

In practical terms, the adoption of the use of electronic spreadsheets in the application of dynamics facilitated the discussion of the project among group members by allowing the values that would result from the implementation of equipment and renovations to be "simulated" more quickly, in addition to facilitating the evaluation and counting of the points of each group's proposals by the dynamics applicators. Aligned with the principles of gamification, the strategy of implementing rounds during the dynamic was crucial to enable feedback to the groups on their project proposals: based on critical reflection on the score obtained and the proposed configuration, the groups were able to improve their proposals, trying new layout configurations and purchased items.

In a future application, already in the planning phase, a system of twists must be implemented, that is, the appearance of new information throughout the dynamics in order to simulate what actually occurs in the real world. Among the information that will be revealed during the design process should be a change in the available budget amount, a new policy for replacing current furniture, and the statement that the perspective of outsourced workers (from contracted companies) will also be considered in the evaluation.

Also in terms of future developments, the formalization of the dynamics presented here in terms of an "application kit" with the main material, manuals and electronic support files is a medium-term approach to enable the use of the dynamics in a greater number of contexts. Furthermore, the implementation of a computational version of this dynamic is under development. The application of questionnaires to assess the effectiveness of dynamics for learning AET is a natural step.

The importance of developing new forms of teaching and learning in the context of the fields of knowledge presented in this article is pressing, therefore, when considering the current reality of students and particularities of the areas studied, with the example of dynamics presented here being an initial contribution to the development of learning objects that support the approach to the theory and practice of Ergonomics and Work Design.

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