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Active methodologies with the use of integrated mock-ups to the teaching of the logistic subject

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Abstract**—** *This report is about the use of an active methodology by means of practical activities in a preexisting multimodal mock-up that serves as a teaching instrument. It happened in the night business management technology undergraduate course in the fourth semester. The logistic and practice subject involved the integration of the logistic knowledge and the mock-up by the means of the use of QRCODE tags that could send the visitor to the mock-up to a website where there is an explanatory text for each situation of the mock-up. Concomitant with this activity the student also can insert the company that they created in the course integrator project (CIP) in the mock-up in a way that was coherent and credible with the context. The goals had been met successfully in a way that students could not just integrate knowledge, but also theoretical and practical aspects.*
Keywords**— active methodology, integration, logistic teaching, QRCODE, technological teaching.**

I. INTRODUCTION

The place where this work started was in Fatec Indaiatuba. Fatec Indaiatuba "Dr. Archimedes Lammoglia", located at Dom Pedro I Street, 65, in the Cidade Nova neighborhood, in Indaiatuba, SP, Brazil, is an undergraduate courses unity of State Center of Special Technological Education "Paula Souza" – CEETEPS, known as "Centro Paula Souza", a linked local authority (autarchy) to the Economic Development, Science, Technology and Innovation Department (SDECTI) from São Paulo State Government, that rules 73 Technology Colleges (FATECs) and 223 Technological Schools (ETECs) (CENTRO PAULA SOUZA, 2018).

Fatec Indaiatuba was founded in 1993 and Paula Souza Center was founded in 1969 aiming to make skilled labor to the job market. The name Paula Souza was given to pay homage to the professor and engineer Antonio Francisco de Paula Souza (1843 – 1917) that founded the Polytechnic School of the University of São Paulo (Poli-USP) and always defended the school part as a mean of making professionals (CENTRO PAULA SOUZA, 2018).

Curious it, it was in the early 70s of the 20th Century, when employers in North America and in Occidental Europe begin to look for professionals specialized in logistics, this interesting management area, and the first concepts of the business supplies chain had been based. The current undergraduate courses (Fatec Indaiatuba, Dr. Archimedes Lammoglia, 2018) of Fatec Indaiatuba are business management, services management, foreign trade, computer network, analysis and development of systems and airport logistics. All of them three years length.

The undergraduate course in which this report happened is the business management technology in the night shift.

The subject was logistics with four hours per class every week and in this semester (the first of 2019) it was divided in two days with 2 hours per class for the week. The total workload to twenty school weeks is of 80 hours per class.

The class's practice was active methodology, having the professor as a facilitator and the mediation tool was a lab where there is a multimodal mock-up, teaching instrument resulted from a study project that had the use of the mock-up to the improvement of the logistics teaching (Junior, 2014). Professor counted with the orientation of his doctor's degree guide to the execution of the activity.

II. CLASS PURPOSE AND DEVELOPED SKILL

Class purpose is the improvement of the logistics teaching through activities semiautonomous with academic challenge providing to the student, more autonomy in the process of the knowledge achievement, in a way that is capable of identifying, relate, and plan what they are going to do and in this process the search for knowledge

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(research) in view that not all subjects or texts to subsidize what is done is given prior, these come up.

Another skill is the capacity of working in group, understand differences and organize the different perspectives and views to a common goal, cooperate, congregate and organize.

III. A MOCK-UP AS AN INSTRUMENT

In the process of teaching, it is ensured by the studies of Vygotsky (1991) that the process of assimilation is through signs, as it was already approached previously. Despite signs and instruments being different, they can be used in the same way in processes of learning.

One of the possible ways is the use of mock-ups as teaching instruments. This is not an unknown way, in the doctor's degree thesis of Francischett (Francischett, 2001), the author corroborates the viability of this instrument in Geography teaching and uses not only Vygotsky, but also uses Pierce's work to explain that the use of signs in teaching uses the triad = relation, relativity and intermediation. Semiotic is, necessarily, triadic: when relation gets into experience.

It is established the relation of the interpretant, respective and consequently, a third party (terceiridade) (Silveira, 1989). A representation is an object and can be an instrument.

As it has been described, mock-up can be an instrument to teaching, and when it comes to mock-ups, it can contain icons, like replaced signs or a set of signs, or even it can be a sign. Although it can be presented as a model, a scale representation, even as a project draft, that's why traditionally it has been linked to architecture and civil engineer, it can be used in other areas, as in the work of Bergatin (2013) that uses tactile mock-ups to teach chemistry. Therefore, instrument of teaching mediated by the teacher.

This meets Vygostky's studies (Vygotsky, 1991) where he says that social activities, the relationship with the environment shape the formation of the individual.

The use of representative models of a construction idea comes since Antiquity (Salmaso & Vizioli, 2013), it's some kind of construction doll. It was the mean that existed that got closer to simulation virtual models by digital means (Seel, 2017).

Before drawings made with the help of a computer, mock-ups were the ones that worked as a study model or an idea presentation, both of real estate constructions and boats. They were the main of modeling for analysis not only of architectonic aspects or behavior but also to illustrate or exemplify execution processes still in the phase of project.

Until the last quarter of the 20th century, they were the main mean of modeling and representing until computers acquired a capacity of enough processing to be able to reproduce in a virtual way views and aspects of behaviors that it was possible with mock-ups only (CREATIVE MECHANISMS STAFF, 2019).

It is important to highlight that these mock-ups had lots of limitations in representations due to miniaturization, of construction materials and the difficulty of represent aspects as load or structural weight. Over time, the mock-ups, besides being used in architecture and engineering, also went to other areas, the miniaturization and the imitation of elements and pieces in real-size awake the ludic, among the most popular there are model railroading, ship models, model aircraft and car models.

These models, in all of their ways, are not just a hobby, but an interesting educational instrument. One of the most interesting is the Lancashire & Yorkshire Railway School of Signaling (Brook & Munthe, 2009), it's a railway model in reduced scale built in 1912 to the teaching of railway signalization, it has the registry 1995-7856 from the Science Museum Group of UK and it's part of the permanent collection (THE SCIENCE MUSEUM GROUP, 2019).

In this process of digital world emerge the virtual mock-ups and the process of miniaturization also goes through printing in 3D printers making the virtual object becomes real and like this, the assisted and helped by computer projects not only provide a bigger dynamic in the application of the simulation as virtual representations with complex mathematic models that simulate extreme situations or explore flaws in the project, making the fabrication of prototypes not only faster and more economic but also more reliable since the beginning because it anticipates the technical difficulties of accomplishment (Lirola, Castañeda, Lauret & Khayet, 2017).

The simulators can create and operate virtually production systems very complexes and these simulators when adapted to the game, create virtual environments that simulate historical, commercial, military contexts, exploring with great complexity strategical aspects and like this, create and reproduce virtual worlds based on credible aspects when technically grounded (Himma & Tavani, 2008).

The telic paratellic engagement in these situations is very big due to the fascination that they exert, like it was commented previously, adults are the biggest buyers of electronic games (Deterding, 2013).

However, even with the advance of the virtual, of the digital, mock-ups find their space inside education, like

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something plastic, palpable, especially if they count with the planning and construction by the students. To explore this palpable part of the process, modeling with the hands, drawing, tracing, measuring, cutting and gluing provide a feeling of accomplishment, of construction. Mock-ups can be made of a various number of materials easily found in people's daily basis, technical materials only are not necessary in the world of professional mock-ups if the goals were didactic and ludic to engagement and learning (Junior, 2018)

IV. ACTIVE METHODOLOGIES

In the teaching of teenagers and adults the traditional methodologies, that were developed and applied over time, where the student assumes a passive part and all the unfolding of the class is focused on the teacher or the subject, doesn't have so much effect compared to previous generations. Although it's about adult literacy, the work of Faoto & Dias (2014) has in its reflections the heartwood of teaching to adults.

> In contemporary times, the processes of schooling that wish and give opportunity to the emancipation demand interdisciplinarity, where the educator can see the whole picture, not by the simple summation of parts that make it, but for the perception of that must be allowed that the thought and the learning happen based on dialogue among the several areas of knowing.
>
> (Faoto & Dias, 2014, p. 399)

Social and technological factors have been altering the behavior and expectations of students, especially among the young adults (Abi-Raad, 2018) . That's why active methodologies of learning where the student is put in an active position have been studied. The active methodologies are many, but they have this main characteristic: putting the student as an agent of their own learning (Rocha & Lemos, 2014).

These social and technological aspects had already been explored previously and we're given a few tips or ways to these active activities applied on the teaching. The most common are inverted class, games, problems method, projects method, hybrid teaching, study and method of case and group activities. The mobile devices is another example that can be used in this social and technological context. (Pereira & Dinis & Gouveia, 2019).

There are a lot of ways to explore the active methodologies (Committee on Developing a Framework for an International Faculty Development Project on Education About Research in the Life Sciences with Dual Use Potential, 2013, p. 29) and it is not intended to run out of the subject, it is intended here to explain two concepts that justify themselves by related aspects in this work and its conduction: Learning Based on Problems and Learning Based on Projects.

According to Sankey and Hunt (2003) the active methodologies are justified by the following aspects:

Search for knowledge with technologies.

Stimulation of curiosity.

Doubt point—the academic challenge.

Process of facilitation by the professor.

Preparing and planning of the professor, the students and the resources.

Feedback about the process to the students.

For that to be possible, a change of posture or work, putting the student as central point and actor in the search of their knowledge, demands an educational project and this educational project might be confused with the learning process.

Therefore, it is important to understand how these methodologies intertwine.

According to Davis and Wilcock (2004, p. 51) the study of case or the method of case (Sharma, 2006) is a popular way and plays a very important part in the development of abilities and skills. However, Sharma (2006) explains that study of case is used in teaching, may or may not have some practice involved and method of case refers to real life cases, therefore, it is understood that modified cases by the teacher aiming certain aspects are study of case. According to the same author, study of case was created in 1880 in Harvard (Sharma, 2006, p. 51) in Law School by Christopher Langdell. After that, the method was extended to other areas of education, highlighting health/medicine area, besides, of course, the area of law itself.

By the reading of the authors (Davis and Wilcock, 2004 and Sharma, 2006) it is noticed that is a method well documented, because as a method it doesn't apply when the problem is identified soon (or given soon). Davis and Wilcock (2004, p. 51) consider the study of case an activity centered in the student.

In this method of case there are multiple views or approaches to the problem, fact that students learn in a more effective way when these are involved in the case, involved in processes of learning so they can approach the

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case by multiple ways or lines of approach, which can also be found in Hiller (2002, p. 208) when she explains that the more details the case has, the more students can develop and learn and Sharma explains that the key to success to the method of case is the choice of the right situation-problem (Sharma, 2006, p. 195).

An important detail is about the difference of the study of case or method of learning based on problem (problem-based learning – PBL), because PBL encourages the student identifying their own learning goals and the study of case (Davis & Wilcock, 2004, p. 51) has more elaborated and outlined parameters in the case that it is introduced to include scientific principles and specific programmatic contents that the teacher wishes working to develop the learning inside the menu or research line.

Here I would like to explain the difference of problem-based learning (PBL) from project-based learning (PjBL), in the project-based learning usually there's something that needs to be done or elaborated (Uden, 2006, pp. 38-39), can be a product (Farenga, 2005, p. 189), artefact or a process. And as it has been said in the problem-based learning, all the focus is in the problem. Project-based learning is closer to study of case. (Davis & Wilcock, 2004, p. 51).

Project-based learning results in more engagement of the participants and provide more experience and in this kind of learning, the critical thought and cooperation are more developed (King, 2017).

Board 1 – Comparison of the methodologies

Method of Case/Study of Case	Problem-based learning	Project-based learning
Guided by the case offered by the teacher. The case is already prepared to reduce the possibilities of solution.	Guided in the activity offered by the teacher.	Problem is given, but how it will be approached is defined by the students.
Teacher supervises	Teacher supervises	Facilitator teacher.
Students must analyze and point out the possible solutions and define the best solution or strategy to work the case out.	Students must produce a solution or strategy to work the situation out.	Work the problem out must be part of the task, but the focus in on management, but there isn't barriers or limits.
It demands study and the solution is based on prior knowledge	It demands study and the solution is based on prior knowledge	The students are the ones who define what will be needed to work the problem out.

Based on: (Davis & Wilcock, 2004, p. 52); (Uden, 2006, p. 38) and (Moallem, Hung, & Dabbagh, 2019, p. 91).

These forms of active methodologies now begin to intertwine with TICs, forming new arrangements, like the blended learning and also forming what concepts as a flipped classroom and are methodologies or processes still in transformation (Reidsema, Kavanagh, Hadgraft & Smith, 2017, pp. 6-10).

The work of Trevelin, Pereira and Neto (2013) introduce an interesting study of case with flipped classroom with a duration of two years and involved 148 students, in this work, using active methodologies they managed to reduce failure rates comparing to traditional methodologies

> By the data presented, it is possible to see that there was a quantitative improvement of results because the number of failed students decreased and also there was a qualitative improvement because the great majority of students, that is, 90% of them say through the questionnaire having preferences by the new applied methodology.
>
> (Trevelin, Pereira & Neto, 2013, p. 12).

The authors (op. cit.) took care of mentioning that other variables must be taken in consideration in the analysis of these results. What meets other work, with application of the learning based on projects, in this one, authors Santin and Ahlert (2018) highlight that the time dedicated to studies and prioritization or not of this time might affect the yield, in this work 90% of the students worked.

In the work of Piva Jr. and Cortelazzo (2019), authors report that they used in 20% of the classes (the most difficult topics) of the subject of TI Fundamentals. The methodology of the flipped classroom and the results were very interesting: "Results indicate a significate improvement in learning, superior to 65%, and a better global learning from students, expressed by the reduction of the standard deviation of its averages" (Jr. & Cortelazzo, 2019, p. 34).

Another interesting work about active methodologies is Freeman's (Freeman et al., 2014 a) that had analyzed 225

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studies and identified that active methodology in these studies were 1.5 times more efficient than traditional methodologies. However, the authors were also cautious regarding the results about the universalization of results because of heterogeneity.

Even though, Freeman et al. work (op. cit.) receive critics in relation to what they determine passive methodologies, because they use the term "lectures". Among other issues, the critic was that it didn't occur a way of distinction or categorization these classes or expositive methods (Hora, 2014), which became necessary an explanation by the authors (Freeman et al, 2014 b) that the analysis didn't make no distinction of methodologies purely expositive and some other ways combined, which it could elevate even more the efficiency of active methodologies from those purely expositive.

This is for demonstrating how difficult it is to determine by quantitative means, processes so complex that involve learning and its methodologies. However, we can't deny that time and perseverance in healthy and consistent teaching strategies improve teaching.

V. USED ACTIVE METHODOLOGY AND ITS JUSTIFICATION

The used methodology was the flipped classroom one by a mediation instrument that is a complete mock-up that represents a supply chain with all the modals and other actors in the supply chain, including a city with approach to urban mobility, like a freight village with many primary and secondary business. Active methodologies are a very interesting teaching method, an example large used is the beer game, a complex game used to apply knowledge to solve logistics problems (Lau, 2015).

The students from the business management course have course integration projects (Projeto Integrador de Curso - PIC) that is elaborated in group, and in the fourth semester they must develop the business (product, commerce or service) of the company already created in third semester. This project continued in every semester involve the subjects of the semester in a way they integrate as the work advances. For this accomplishment, this is organized in groups about six students, may vary for more or for less, in a way that adjusts to the reality of each semester (Fatec Indaiatuba – Dr. Archimedes Lammoglia, 2017).

Parallel to this integrator course project (PIC) in the subject of logistics, it was offered the opportunity to students to integrate the integrator course project in the mock-up or the accomplishment of other activity suggested by the teacher in the mock-up, being able the students to use their own PIC group or other form of organization.

When the student's choice was to use what they had been developing on PIC, practice is the inclusion of the business, commerce or service inside the representative structure of the mock-up, for example, the installment of a commerce in the mockup's city and this commerce must be both representative to PIC and the mock-up's context (coherence and likelihood).

The suggested activity by the teacher was the identification of parts, pieces, situations, setting and/or installments in the mock-up related to the logistics and supply chain. The interdisciplinarity context create a complex situation and challenge opportunity for the students to apply the knowledge (Power & Handley 2019).

For both options, it must be also elaborated an explanatory text, the recording of this text in the mock-up's blog and a making of a QR CODE (Prass, 2011) to be fixed next to the representative item that the text describes/explains. This way, through an app that can be downloaded from the internet, it is possible to read QR CODE and this will send directly to the text already recorded in the blog that explains that detail or aspect of the mock-up.

What justifies both suggestions are the use of the ludic (mock-up) as a stimulation element to young adults, the academic challenge that the suggestion represents and at the same time not deviating from the content of the classes in the subject of logistics and the integration of that inside the context of the integrator course project, that already contain subject aspects, but also makes the extrapolation to other logistics aspect and the supply chain.

> The higher education sector is constantly changing for its modernization and adaptation. The main challenges or challenges of the university derive from new scenarios and agents in addition to the emergence of educational alternatives. Thus there is an increase in demand with diversification by age and needs, both territorial and social, higher levels of inter-nationalization, new processes (Open Learning or the appearance of the mooc), restructuring of the teaching offer, as well as the need to face economic, financial or

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> technological challenges, in addition to the formation of university spaces, such as the appearance of the European Higher Education Area, among other initiatives (Neave and Veiga, 2013; Espinosa-López, 2015; Lu-que et al., 2015).

(Doña Toledo, L., & Luque Martínez, T. 2019, p. 2).

Another strand is the connection of the activities with social media, in this case, a blog (fatecid.wordpress.com), the software use, in this case a generator of QR CODE and the first steps into the internet of things – IOT (Behmann & Wu, 2015). This involves both the research necessity for the text elaboration and practice activities, print the signs, glue, fixate and other decisions that involve coordination and activity planning from students.

An interesting aspect is the overcome of the virtual world paradox (digital) and physical world, the challenge (Abrantes & Gouveia, 2011), with cut processes, collage, painting therefore very handwork and at the same time with the academic challenge to represent themselves in models, in this case, mock-up, the likelihood and the coherence with the concepts worked in the academic area without leaving aside the cyberspace, whether it's a simple use of a digital media, but with the use of a kind of icon, a sign that works almost as portal, in this case, QR CODE.

Picture 1: 4th semester students from the business management course elaborating the mock-up of their business to be inserted in the city.

Source: Authors (2019).

Picture 2: 4th semester students of the business management fixating the QRCODES that send to explanatory texts.

Source: Authors (2019).

Picture 3: An example of QRCODE used, which sends to the indicated address for the text elaborated by the students.

Porto fluvial

https://fatecid.wordpress.com/2018/12/11/porto-fluvial/

Source: Authors (2019).

VI. LEARNING EVALUATION

The Integrator Course Project it is already worth 20% of the student global grade, already harmonized with all the teachers and inside its competence and with rules, when the student chooses the additional activity with the mock-up, both in the choice of integrating PIC, the mock-up or the activity suggested by the teacher in the mock-up. There's an addition of even 2 points inside the traditional evaluation grade of the logistics' subject. Since it's optional, it's made a division between who chose and who didn't.

Like this, the traditional individual evaluation might worth more (who didn't choose = 10) or less (who chose = 8+ 2 from the activity). So it stays like this: P1 – presentation of the PIC logistic work, P2 – traditional test and P3 – PIC, whose formula is (((P1*0,4)+(P2*0,6))*0,8)+(P3*0,2). When the choice is made for the complementation, the calculus is made inside the P3 grade with the note in the own evaluation to the student's control in a way that is doesn't change the formula in SIGA – Integrated System of Academic Management.

If the student stays in activity in the lab outside their regular schedule, there was also the emission of the certificate referring to extracurricular activities that is a

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report of the Complementary Autonomous Activity. The activities criteria are: cooperation, assertiveness, likelihood and coherence, in a way that places the 0,5 points in each one of the 4 areas.

It was solicited to the participants that they answer a little questionnaire about the activity and about the questions, these ones focus in relation to the activity, what they liked most, what they less liked, difficulties and suggestions to improvement.

VII. RESULTS

A In relation to the participating students, it was found that occurred an elevated engagement, and this happened by the bigger frequency, because there was a purpose, they managed to negotiate their own time, even those who worked got a few minutes more in college in the pre-class. Related to the grade, these ones reached the 2 points very easily, given that the professor as a facilitator gave tips and also made the evaluation of the process and the results.

In comparison with other classes and groups that didn't accomplish the activity in the averaged, without the inclusion of additional points, there was an increase of 19% presenting 1 more point in the grade: point average of who participated = 9,09 and the point average that didn't participate = 7,57. However, there are intrinsic and extrinsic factors among the classes and groups that don't allow to universalize these results.

Another issue was freedom, if the PIC group didn't wish to make the activity, the student individually could make the activity in the mock-up and/or join another group, the and/or is by the fact that occurred parallel activities and generated transverse knowledge (electric, electronic, measures, calculus, several mechanic solutions, etc.) unclaimed or in the domain of the subject menu.

In relation to the cooperation, this one could be observed through work organization, they shared the tasks and since it's a mock-up, they should reunite the parts or integrate the tasks, because there was both a need of coherence and likelihood. The direct observation from the professor, also in activity, allowed to hear the conversations among the group, intergroups and that are: when and how they arrange what they are going to do, the material and tools selection and the way of doing it.

In the subject of the logistics, the students' exposure to the mock-up environment, which is very complex, allowed to make connections and interactions of their own texts that elaborated with other texts from previous years and with the representative elements in the mock-up. The effectivity, fulfillment of the tasks as well as the cooperation aspects, assertiveness, likelihood and coherence were totally accomplished by the students.

The QRCODE use to generate a link in a blog with explanation about what QRCODE indicates may seem little in relation with the internet of things, however, it's an interesting relation between a manual and a digital activity, also having the text and yet it must be considered that the blog is accessed by a smartphone or another mobile media technology.

The answers given by the students and their impressions about the task execution were unanimously aligned with the results and with the impressions, in relation to the difficulties pointed by them were exposed in the next part.

FOUND DIFFICULTIES

The biggest difficulty was that it wasn't possible to include the whole classroom, out of 39 students, 18 agreed to do the activity. In their allegations, there was lack of time and/or there was already too many activities (like PIC), however, talking to those who accepted, it's that the ones were having a very abstract idea of what would be executed, this way, the whole class should inserted in the context from the beginning.

The students pointed as the biggest difficulties: lack of time to the task's execution, more space to the execution of the manual activities besides the need of more organization of materials and tools.

VIII. CONCLUSION

It's possible to conclude that the goal of the activity was accomplished with success in view of the obtained results, the perception of the professor and the impressions collected from the students both talking to them or by means of questionnaire.

The use of the mock-up as an instrument mediated by the professor was an effective and interesting active methodology and provided an opportunity in the logistics teaching using ludic elements and clear and well defined goals, the conjunction of texts elaborated by the students and the identification of parts and situations in the mock-up or the insertion of a mock-up of an integrator course project had brought the needed element of academic challenge.

From the difficulties pointed out, that doesn't stop the continuation of this practice, it's up to the professor to insert in the logistics' class the integration of the mock-up to the students' PIC, giving indications of what can be done and at the same time, exploring students' creativity. The space issues can be solved with fixed boards on the backrest of the desks in the classroom to activities of pre-montage to assemble, as well as including the classroom arrangement and the organization of the goals, actions that

can be done over classes, putting together practice with content.

Now, the use of the digital brought an interesting dynamic, the QRCODE is now used to interact knowledge about logistics inside the mock-up with students' own devices, therefore, putting together the medias with something more traditional, that is the mock-up itself.

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