Trello as Virtual Learning Environment and Active Learning Organiser for PBL Classes: An analysis under Bloom's Taxonomy

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Abstract

Trello is a cloud app based on Kanban concept and also available for desktop mobile devices. The app has plenty of boards that help projects' development under SCRUM concept. Trello is not originally designed as a Virtual Learning Environment (VLE) but it is recurrently adopted by one of the paper authors as a VLE for Project-Based Learning (PBL) classes development. It is also used as a formative assessment platform. The present research brings a case study under Trello point of view about a PBL class from a specialisation program named Creativity & Innovation where students chose to develop a project related to a vegan pizza bike entrepreneur in a Brazilian Applied Science Institute. The students from this PBL class came from distinct study areas like Graphic Design, Business Administration, Social Communication, and Journalism as well as Production Engineering since the program has an interdisciplinary character. Active Learning was the core learning approach taking PBL as a framework for it. According to the methodology, the students collaboratively identified the steps for project development from the "pizza bike" to the business areas related to it. For instance: visual identity, digital marketing, financial and accountability, manufacturing, etc. After that, the students supported by a tutor proposed teams for each areas identifying team tasks. From the beginning until the last activity, Trello as a VLE was disruptively essential for project organisation as well as their project success. A model based on Bloom's Taxonomy and other authors were proposed for the results analysis and it was possible to conclude that Trello as an innovative VLE and PBL organiser seemed to be positive from the author´s/tutor´s perception to the students' feedback and project results.

Keywords: Active Learning; PBL; Trello; Cloud Education; Bloom's Taxonomy; Virtual Learning Environment.

1 Introduction

Project-based Learning (PBL) is an active learning approach and philosophy that brings a multitude of interdisciplinary process and students' curricula gain. According to (Stoicoiu & Cain, 2014) the PBL as a learning approach can improve students' communication, individual growth, lifelong learning and team-work. All of them are desired skills by the job market. These skills are explored by students in their PBL experiencing since the projects try to resemble real life. And, much closer the project is of the real life, more opportunities students have to develop these skills (Stoicoiu & Cain, 2014).

Despite these advantages for students' curricula, PBL approach promotes a learning related to the project process that is usually hard to follow and control. For this reason, the absence of process operationalisation methodologies (e.g. SCRUM) can be a risk for the PBL effectiveness. Not always process operationalisation methodologies (POM) are full-adopted during classroom project development. In some cases partial-adoption of these methodologies are associated to a virtual or physical learning environment allowing a minimum control of the project process.

In this way the PBL was taken as active learning approach in the Entrepreneurship & Innovation Program of the Instituto Federal Fluminense. This paper aims to describe and analyse the results from a case study related to the Trello adoption as Virtual Learning Environment (VLE) in a PBL classroom of this program. Bloom taxonomy will be used to discuss the results obtained.

This paper is organized in six sections. The first section introduces the objectives of the paper. A short background related with PBL and Bloom taxonomy is presented in section two. Third section reviews the Trello for Education tool and SCRUM methodology. Study context is described in section four. Section five presents the main outcomes and finally, the last section wraps-up some final conclusions.

2 Background

This section brings the subjects related to the present research: Project-based Learning (PBL) as pedagogic framework, Trello as Virtual Learning Environment (VLE) & SCRUM thinking and Bloom's Taxonomy as an element of analysis model.

2.1 PBL & Bloom's Taxonomy

Project-Based Learning is an active learning methodology considered as student-centred approach. Student-centred approaches are different from teacher-centred approaches since these last ones are common in conventional teaching/learning practices and student-centred approaches referred to the result of transformational teaching/learning where the teacher assumes a role of a coach and a mentor and peer-to-peer networks among students are formed, emphasing the balance in the team and individual performance (Zhang, Zimmerman, Mihelcic, & Vanasupa, 2008). Being a student-centred approach, PBL has characteristics such as the Inductive Learning, meaning that basic material is introduced as soon as the need is established in the context of a question, problem or project assignment.

PBL also implies other learning approaches such as Collaborative and Cooperative Learning which calls for students interaction and working in a group to learn, apply course materials and work in structured assignments or projects under conditions that assure their interdependence, individual accountability, periodic face-to-face interaction, appropriate development and use of interpersonal skills and self-assessment of group work (Felder & Brent, 2006). Flipped-classroom is another learning approach identified in the PBL context since instructional content is delivered to the students outside the classroom and, usually, by themselves (Flumerfelt & Green, 2012).

For PBL development, students should use communication and information means such as blogs (Vicente, Mattarredona, & Alves, 2014), Facebook, Asana, Trello, or others web tools (Bittencout, Pimentel, Lago, & Santos, 2010). According to (Harmer, 2014), the key features of PBL models are: 1) learning by doing; 2) real world problems; 3) role of the tutor; 4) interdisciplinary; 5) collaboration and group work; 6) an end product.

PBL has been implemented globally in different academic years with interesting results (Alves, Moreira, Fernandes, Leão, & Sousa, 2017; de Graaff & Kolmos, 2007; Guerra, Ulseth, & Kolmos, 2017; Lima et al., 2017; Pereira & Barreto, 2016). PBL provides competences such as communication skills, leadership, project management, problem solving, among others that according to various studies and reports on the labour market are valued by employers value (Alves, Leão, Moreira, & Teixeira, 2018; ASME Board on Education, 2012; Jollands, Jolly, & Molyneaux, 2012; Santos, Simon, Guimarães, Amorim, & Vieira Junior, 2017; UNESCO, 2010).

Such competencies are not achieved in the traditional teacher-centred approaches which, normally, use tests and exams to evaluate students' competencies that are typically the competencies of the lower levels of Bloom's taxonomy (Bloom, 1956). These competencies of lower levels of a six-level scale are: ability to memorise facts, procedures and descriptions; and the ability to describe in other words facts and concepts; of interpreting and extrapolating. PBL supports the high-order levels this taxonomy: apply, analyse, evaluate and create. Bloom's Taxonomy consists in a framework of cognitive skills that help students and teachers in the learning process. This framework provides a hierarchy of critical thinking levels represented by keywords and its related student's action (verbs) as detailed in Table 1, Dimension 3 in Outcomes section. Authors like Ekren & Keskin (2017) and Stone (2004) have been developing and adapting Bloom's Taxonomy for specific models related to learning researches.

Additionally, PBL is also used as an educational strategy to improve students' attitudes towards science, technology, engineering and mathematics (STEM) as well as their achievements (Capraro, Capraro, & Morgan, 2013; Han, Capraro, & Capraro, 2015; Kezar, Gehrke, & Samantha, 2017; Tseng, Chang, Lou, & Chen, 2013). Concerning/Regarding projects development based on conceiving products such as robots, students are capable to collaborate, program and construct in a team setting (Eguchi, 2016). This was observed in the Hispanic students in US classrooms by (Han, Capraro, & Capraro, 2016) and in the sustainability concepts learning of Civil Engineering undergraduates students by Fini, Awadallah, Parast, & Abu-Lebdeh (2018). As so,

it has a positive impact in the communication and collaboration skills and their entrepreneurship spirit is stimulated (Alves & Eira, 2015). Students make PBL an effective way to teach STEM in an integrated and meaningful way (Berry, Chalmers, & Chandra, 2012).

PBL is an active learning methodology capable of providing the competencies for 21st Century that, according to Fonseca (2017) are : complex problem solving; critical thinking; creativity: people management; coordinating others ?; emotional intelligence; judgement and decision making; service orientation; negotiation and cognitive flexibility.

2.2 Trello (VLE) and SCRUM

Trello is currently part of the Atlassian Company portfolio (Cannon-Brookes, 2017), but was released in September 2011 in the applications session at TechCrunch Disrupt, being its conception strongly inspired by the Kanban method (Finley, 2014). Since its launch, it has been gaining more and more fans because of its flexibility of use and dynamism in different contexts.

Although not mandatory, Trello is based on japanese Kanban concept and can act as a virtual environment for the SCRUM application that is one Agile method. Kanban is a method based on a visual system for work management. (Kabanize, 2019; Digite, 2019). SCRUM consists in framework used for project management and can be a useful thinking framework for PBL and also Trello (Sutherland & Schwaber, 2017).

Considering the academic universe and its multidisciplinary approaches, Trello has been an alternative of use in the learning environment, by incorporating a platform that allows collaborative and interactive work, promoting the sharing of knowledge and experiences.

Teachers can use their structure, among other possibilities, to help in the application of the PBL methodology in their classes, following the interaction of the groups, the progress of the work and evaluating the performance of the class with transparency. Some application examples of Trello working in a PBL environment could be consulted in Cervino (2015a, 2015b).

3 Study Context

In Brazil it is very usual a kind of post-graduation course related to a certification/specialisation in general knowledge fields (*lato sensu*) and not related to a Master nor a PhD. This section describes the study context and methodological approach for the research developed among students from a specialisation course in multidisciplinary subject of Management, Design & Marketing in a Brazilian public university. The Project-Based Learning (PBL) experiment happened in the context of a specialisation program named Creativity & Innovation where students chose to develop a project related to a vegan pizza bike entrepreneur based in the food truck business tendencies. The program goal was to promote technical entrepreneurship knowledge among the students as well as skills related to creativity, teamwork, conflict management, risk management and more.

The project was developed during a whole academic semester. For this time the program's tutor suggested to the students to adopt specific digital tools related to project business control named Trello. Usually this development step is not requested by the tutor since the students are free to adopt any tool they want. In this context, students usually choose a chat platform like Whatsapp group that decreases the team capability to control the project processes.

Trello features were previously explained to the 26 active-enrolled students. The students integrate a multidisciplinary class since are all graduated in some of professional fields like: Production Engineering, Business Management, Graphic Design, Marketing, Communication, Journalism and others according to the certification course multidisciplinary subjects?.

After the how-to-do step about Trello, the students were tutor-guided to include tasks related to the project on brainstorm creative group discussion technique. The students got totally free to include data in Trello according to their organising ideas. The students were free to decide how to think about project's tasks as well as organise these tasks in Trello, the teacher's role was to promote short interventions to provoke or direct

students if they forgot something important or were following a very different way from those that would obviously lead to better results.

SCRUM concept (Sutherland & Schwaber, 2017) was briefly presented to the students and a card was created suggesting how to adopt the Sprint's "To Do", "Doing" and "Done" lists to the project development.

The students proposed 10 main Trello's lists according to major project's steps identified by them: a) Administração (management), b) Comunicação (communication), c) Produção (production), d) Redação Facebook (Facebook Writing) , e) Atividades chave (key tasks), f) Proposta de Valor (value proposition), g) Relacionamento com o Cliente (customer relationship), h) Fonte de Renda (income source), i) Estrutura de Custos (product cost elaboration). Part of these lists are presented in Figure 1.

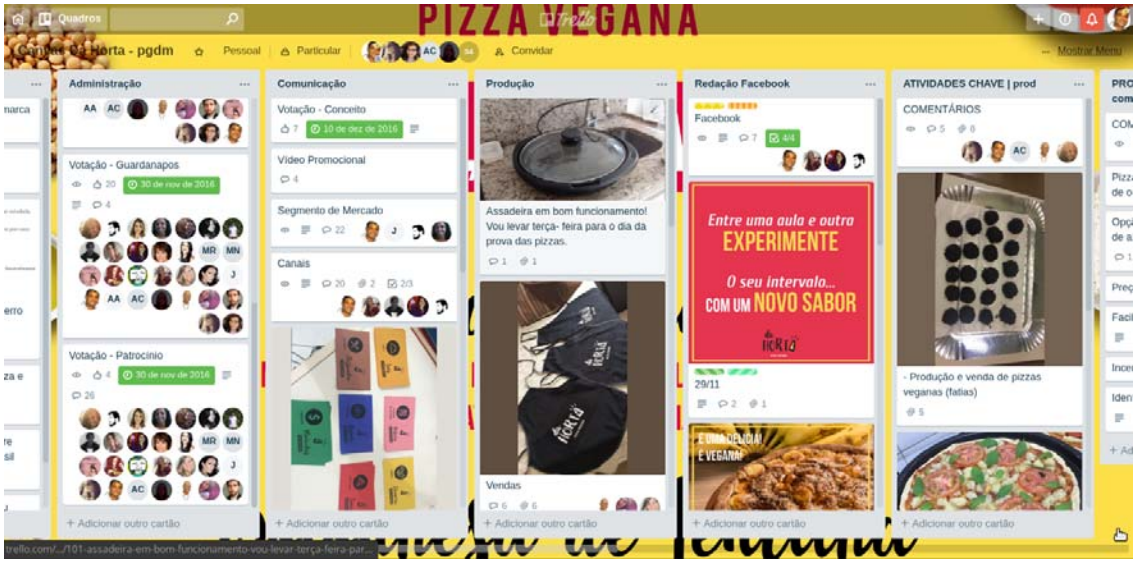

Figure 1: Major project's steps

For each project's task the students created a card in one related list above and include as member the related student task owner. As an example, the card "Relacionamento com Cliente" (customer relationship) in Communication list. Other cards/tasks had all project participants included like "Votação - Patrocínio" (Voting - sponsorship) in Management list.

4 Outcomes

The research's methodology development consists in an exploratory approach based on a set of parameters collected from different authors intending to arise quantitative data about three dimensions according to the Table 1, related to PBL aspects, VLE aspects and learning aspects. Furthermore, a qualitative analysis is proposed detailing aspects from Table 1 aspects.

Dimension 1 is adapted from PBL aspects and criteria from Mansur & Alves (2018) research. Dimension 2, brings criteria adapted from Mezzari (2011) and Norman and Schmidt (2000). It arises aspects that can confirm Trello effectiveness as VLE and project organiser. Dimension 3 aims to identify students learning level according to Bloom's Taxonomy (Krathwohl, 2002).

Table 1 – PBL, VLE and Bloom's Taxonomy aspects on PBL

Dimension 1 – PBL Aspects		
Academic Course Year	Academic year program in the course context	2
Duration (months)	Program duration over a period of time	6
Supporting Courses	Courses related to the PBL program	1
Assessment Tools	Different assessments related to the project	4
Students Dimension	Number of students / teams related to the project	27
Teachers / Coordinators	Teachers / coordinators related to the project	1
Infrastructure	Infrastructures allocated to the project	3
Project Tasks	project's tasks self-proposed by students	39
Flipped-classroom	Delivered instructional content, often online, outside of the classroom	10
Knowledge Acquired	Number of knowledge areas interdisciplinary dealt by the students	6
Dimension 2 – VLE Effectiveness		
Number of Cards	Total number of cards created in VLE	92
SCRUM Cards	Number of Cards related to SCRUM	0
Subjects arose	Project related subjects arose by students	16
Student's Interaction	Average of different cards accessed by project members	8
Project Milestones	Cards from students for Project Planning discussion / Total of cards	72
Theoretical Issues	Number of Cards related to academic themes arose by the PBL	61
Theoretical interest	Students interactiveness in cards related to theoretical material	1
Dimension 3 - Learning Evidences according to Bloom's Taxonomy		
Remember	Evidences (number of cards) of students retrieving relevant knowledge from long-term memory (Recognising, Recalling)	25
Understand	Evidences (number of cards) of students determining the meaning of instructional messages, including oral, written, and graphic communication. (Interpreting, Exemplifying, Classifying, Summarising, Inferring, Comparing, Explaining)	20
Apply	Carrying out or using a procedure in a given situation. (Executing, Implementing)	27
Analyse	Evidences (number of cards) of students breaking material into its constituent parts and detecting how the parts relate to one another and to an overall structure or purpose. (Differentiating, Organising, Attributing)	6
Evaluate	Evidences (number of cards) of students making judgments based on criteria and standards. (Checking, Critiquing)	9
Create	Evidences (number of cards) of students putting elements together to form a novel, coherent whole or make an original product. (Generating, Planning, Producing)	6

Some dimension's criteria demand extra detail. In dimension 1, the highlighted assessment instruments were self-assessment, peer-assessment in the checkpoints related to the project task as well as to the final presentation presented in Figures 2 and 3

Figure 2 - Assessment Instruments

The students made use of three types of infrastructure: the institute's facilities (classroom and external area) and areas outside the institute (student's home). The project tasks were conducted outside-classroom and were fully/completely developed. The classrooms became a weekly coaching meeting,, while the project's tasks were developed by the students in their own home and continually in a flipped classroom strategical learning approach. Some evidences are flyers and folders, cooking aprons and pre-baked pizza dough developed and made by the students out of classroom time.

Figure 3 – Flipped Classroom evidences

In the context of a flipped classroom, the students had the opportunity to deal interdisciplinarily with technical academic fields like Marketing, Accountability, HR, Business Management, Cooking, Graphic Design.

In dimension 2, 72 of 92 cards created in Trello by the students were project's milestones like subjects vote of tasks discussion or checkpoint. It represents 76% (almost 80%) of total cards created and it is an indicative of the great autonomy and student knowledge self-production. Despite this promising results only one cards indicated students' interest in theoretical reading. The list of theoretical references were created with some cards content like: Trademark registration, How to deal with project's uncertain, What to do when your client says: It is expensive!. For a total of six subject-cards only one named How to calculate statistical sample pattern deviation resulted in some card interaction by the students.

While the last two dimensions brought empirical and observational data, dimension 3 brought an analysis related to a traditional and famous model named Bloom's Taxonomy. According to this model, the PBL experience related in this research reached the six levels of learning since the most basic like student's remembering skill until the most complexity level related to the creating student's skill. Remember level evidences are found in cards where students could brought previous knowledge to deal with a problem. For example, the card like Pizza Wrap demanded previous knowledge related to graphic design program, while the card customer relationship demanded knowledge related to the marketing program. The Understand level is evidenced in cards available in the Notes list where students are demanded to confirm their understanding about tasks deadlines and specific procedures. Create level is evidenced by cards that represent organising, planning, scheduling for a new product or project step proposition. For example, the card Questionnaire where the students elaborated and validated the market research for the vegan pizza flavours as well as/and also the flavour-testing day organised by them to eliminate the pizza flavour previously suggested and non-real tested.

5 Conclusion

Usually, there are not specific analysis tools for PBL learning evidencing. For this reason, it seems to be satisfactory the innovative model presented in this research intending to clarify this aspect. The model can be

and must be improved since it is a first version of it. While dimension 3 is the most consistent since it is based in a consecrated theory (Bloom's Taxonomy), dimensions 1 and 2 can be reconsidered/rethought and deepened. Despite that, the model in its whole was conclusive as a tool to bring evidences of PBL effectiveness and Trello adoption as VLE, as well.

Dimension 1 made PBL effectiveness measuring possible. Adaptations where made from the original model since Mansur & Alves (2018) did not consider evidences from Trello. Criteria like Flipped-classroom evidences and Knowledge Acquired are evidences of it.

Dimension 2 evidenced the Trello adoption effectiveness. Despite being based in related researches, the model is brand new/ an innovation in the present study since it had never been proposed before. From its gathered data it is possible to verify that Trello was useful as a task organising tool for PBL classes as VLE scaffolding students to plan, gather and organise their own learning process. Regarding SCRUM thinking, it was evident that the basic knowledge/contents exposed to the students were not a suitable path to make them go deeply in this set of management project practices. The only thing mentioned about SCRUM in Trello was the card explaining how to create the sprint step for process categorising. For next experiments it is suggested that SCRUM concepts be more detailed explained. Other suggestions are experimental researches about how students deal with SCRUM+Trello (as VLE) in two scenarios where SCRUM concepts are previously explained: a) SCRUM mandatorily adoption in PBL and SCRUM as non-mandatory organiser tool.

From the proposition of Bloom's Taxonomy as an analysis tool for PBL effectiveness, Dimension 3 brought evidences that the students have covered/reached the six Bloom's learning categories. These findings were made easier since Trello cards were important elements to identify important aspects like students capabilities of summarising, executing, organising, checking, criticizing and create and assess elements related to their own learning process.

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