# Using Multiple Active Teaching-Learning Approaches in Software Project Management: A longitudinal analysis of students' motivation and learning

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***Abstract*—This article describes the instructional design and evaluation of a course about project management in a software engineering post-graduation program using different teaching approaches and with a focus on active learning. We use four different approaches: digital educational game, non-digital educational game, hands-on activity, and experiential activity. Each one of the activities is evaluated for the aspects of motivation, user experience, and learning, following the MEEGA evaluation model and Cidral's experiential activity model. To verify the perceptions of students over time, we also assess graduated students that have concluded this course after two to four years, considering the aspects of motivation and learning. Results indicate a high level of approval for dynamic activities, regarding both motivation and learning. Activities with greater impact on motivation and learning are dynamics and educational games, group practical activities, and group theoretical activities. Among the factors that most influence students' motivation, we highlight: active learning, teacher knowledge, the taste of the area, and teaching methods. We realized that there was no significant variation in the perception of the activities by students over time.**

***Keywords*— student motivation, project management, teaching-learning approaches, active learning**

## I. Introduction

Statistics show that information technology projects still have a significant number of failures and cancellations. The Chaos Report shows that, in 2015, only 29% of projects were completed successfully and 19% were canceled [*1*].

Although according to [*2*] most model curricular guides emphasize teaching Project Management (PM), we assume that teaching is not satisfactorily promoting the use of best practices in real projects.

According to [*3*], the PM course is theoretical in its nature, being a challenge to teach its contents since it can be unattractive when taught theoretically. For Ojiako et al. [*4*], teaching and learning initiatives for PM require new and non-traditional ways of thinking. One of the main challenges in software engineering education is to provide students with meaningful experiences, which they will find useful when entering the labor market [*5*].

Practical activities allow the student to be more proactive and get involved while learning. The combination of several approaches can be considered a key to facilitate the teaching and learning process [*3*]. The best available evidence suggests that faculty should structure their courses to promote collaborative and cooperative environments [*6*].

There are different approaches and teaching methods for PM, such as the use of serious games [*7*] [*8*] [*9*], gamification [*10*], and Project-Based Learning (PBL) [*11*], among others. However, despite literature suggests the importance of different teaching strategies for PM courses, few of these works feature in the same study the use of different approaches and teaching methods for the whole content of the course.

In addition, we did not find works that evaluate the effects of these approaches after the completion of the course and practical application in industry. In this context, this paper aims to evaluate the use of different teaching and learning approaches during a PM course in a post-graduation program in Software Engineering and assess whether these approaches were significant for the graduates.

This paper reports, therefore, the implementation and evaluation of four different integrated teaching and learning strategies, in three classes of a post-graduation program in Software Engineering, for three consecutive years. The evaluation includes students' motivation and learning in the proposed activities. In a second moment, we also evaluate the graduates of these classes (after 2 to 4 years), to verify the effectiveness of the approaches over time.

This paper is divided as follows: Session 2 presents related papers on PM education; Session 3 describes the method used in this work; Session 4 presents the teaching approaches that were used; Session 5 presents the results; and Session 6 discusses the results and presents the conclusions of this work.

## II. Related Works

Several papers report the benefits of different approaches to PM teaching and learning, especially those based on active and participatory learning, such as PBL [*12*], educational games [*7*]

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[*9*], hands-on approach [*13*], and simulation-based approach [*14*]. However, few studies describe the use of more than one teaching-learning method during a whole PM course, and we have not found works that make a longitudinal evaluation to verify the efficiency of the methods after some years.

Hussein [*15*] describes a blended learning model applied to 64 students of a PM course. The model involves lectures, handouts, additional papers, quizzes, guest lectures, company presentations, video lectures, in-class gaming, and the game-based student response system "Kahoot". The results of the evaluations show a high overall satisfaction of students with the course. Regarding learning, the instructional methods best evaluated were Kahoot, lectures, and in-class games. Otherwise, the worst evaluated were guest lectures, company presentations, additional papers, and quizzes.

Ibrahim [*3*] presents a case study of a project management course that includes lecture, lecture-related questions and answers, hands-on computer assignments using software, and a final project to practice the concepts and techniques learned. The author applied a survey to 93 undergraduate students, 6 from e-Commerce, 31 from Entrepreneurial Management, 10 from System Security, 5 from Software Engineering, and 41 from Networking Systems programs. The students evaluated the course, and the main result is that hands-on activities and lab sessions facilitate the process. The author does not present details about the instructional methods used, and besides not being specific to software projects this research also does not include the implementation and monitoring phases of the project.

Tuladhar et al. [*16*] describe an approach to enhance student engagement in an engineering project management course by using mixed-mode teaching which includes face-to-face lectures and active student-centered project-based learning through an authentic industry project. The end of semester evaluation showed that 71% of the students agreed that the assessment activities helped them understand the subject. As results, 60% of the students agreed that they were overall satisfied with the subject and 31% of students remained neutral. The study does not mention the number of participating students.

Therefore, although there are works reporting the use of mixed approaches in PM, we did not find specific studies for managing software projects, using the hands-on approach as the main learning method. In addition, we did not find works that evaluate the effects of these approaches after the completion of the course and practical application in industry.

## III. RESEARCH METHOD

Sixty-two students from <<omitted for blind review>> participated in the study: 20 in the year 2013, 21 in 2014, and 22 in 2015. The PM course has 45 hours, and its contents include the whole project management process based on PMBOK[1] (Project Management Body of Knowledge) [*17*].

In addition to lectures, four other approaches were used and integrated to the teaching strategy: i) practical/hands-on activity "*Mão na Massa*" [*18*]; ii) experiential activity "*PizzaMia*" [*19*]; iii) digital educational game "*ThatPMGame*" [*20*]; and iv) non-digital educational game "*RiskGame*" [*21*]. Table I details the participants for each cohort and cross-session. The evaluations of *Mão na Massa*, *ThatPMGame*, and *RiskGame* activities were not applied for classes indicated with "NE".

TABLE I. RESEARCH SAMPLE SETUP

| | | In-class evaluation | | | | |
|---|---|---|---|---|---|---|
| ***Group*** | ***Sample*** | ***Pizza Mia*** | ***Mão na Massa*** | ***That PM Game*** | ***Risk Game*** | ***Post Evaluation*** |
| Class 1 | 20 | 17 | NE | 17 | 16 | 19 |
| Class 2 | 20 | 19 | 19 | 14 | 16 | 15 |
| Class 3 | 22 | 13 | 16 | NE | NE | 12 |
| Total | 62 | 49 | 35 | 31 | 32 | 46 |

a. NE – no evaluation

We used two different evaluation models, according to activities format. The evaluation of the games PizzaMia, ThatPMGame, and RiskGame, were performed using the MEEGA evaluation model for games [*22*]. The evaluation objectives proposed by this model are: i) identify the level of satisfaction and motivation of students with the activity; and ii) identify what students learned as result of the activity. The MEEGA model proposes a self-assessment questionnaire, using a Likert scale with 5 points (-2 to +2) to each question (Fig. 1).

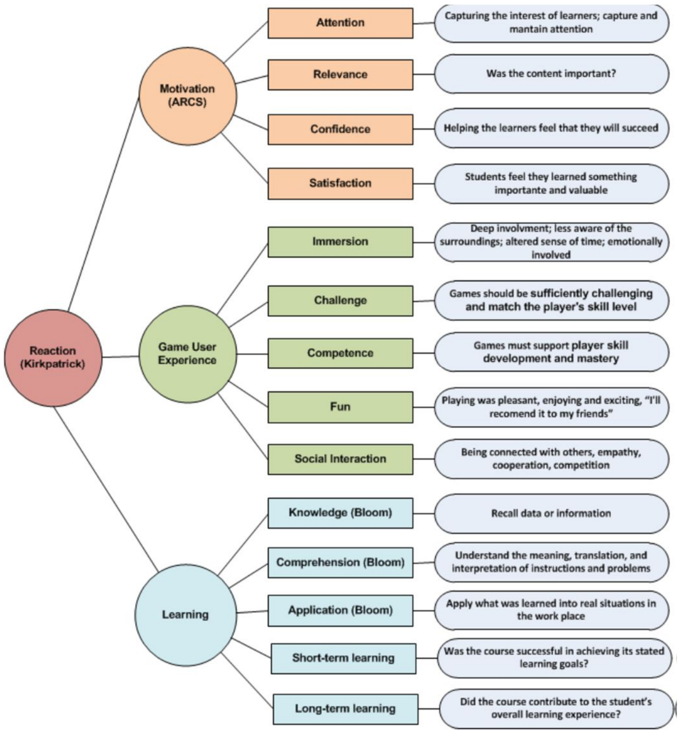



Fig. 1: Structure of MEEGA evaluation model

The evaluation of the Mão na Massa activity was based on the model proposed by [*23*] based on Gredler [*24*], this being a

[1] PMBOK is a set of standard terminology and guidelines (a body of knowledge) for project management, resulting from work overseen by the Project Management Institute (PMI).

model focusing on experiential activities and simulation. This model is composed of the following groups of aspects: personal development, problems nature, the relationship between papers and problems, events control, format and motivation, the sequence of events, materials, feedback, and coordinator (Fig. 2). This model proposes a self-assessment questionnaire, using a Likert scale with 4 points from completely disagree to completely agree, to each question.

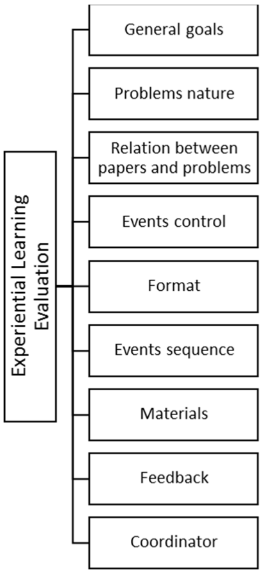



Fig. 2: Structure of Gredler's model

To assess the effectiveness of the methods used, after a time, we applied questionnaires to graduated students (two to four years after attending the course). For this, we developed a questionnaire online to be answered by students, including the following items: i) perception of the knowledge and importance of the course; ii) teaching methods most remembered; iii) learning promoted by teaching methods; iv) motivation promoted by teaching methods; and v) impact factors on student motivation.

## IV. TEACHING APPROACHES

The content of the course was divided according to the process groups proposed by the PMBOK so that as the content was presented, students could apply it in a real project. To this end, the *Mão na Massa* practical activity was the basis for the course and the other approaches were used to supplement learning. To reinforce the content at the end of the course, we applied the experiential activity *PizzaMia* to bring together the concepts and techniques learned.

Table II shows the breakdown of the hours and proposed activities. Initially, four hours were used to expose the contents of the course, introducing the first concepts of PM (project definition, triple constraint, PM guides, and methodologies) and explaining the workings of the other activities to be carried out.

After that, the hands-on activity Mão na Massa was applied, consisting of the actual application of the PMBOK process groups in a software project. The class was divided into teams of 5 or 6 students, and each team received a different project to work. The contents were exposed briefly by lectures, examples, and, just in the following, the learned subjects were applied in their group's project using templates of the documents to be generated when it was the case.

TABLE II. SYNTHETIC INSTRUCTIONAL PLAN FOR THE PM COURSE

| Phase | Methods | Duration |
|---|---|---|
| Initial Conceptualization | Lecture classes | 4 hours |
| Active Learning | Lecture Classes + Experiential Activity + Educational Games | 36 hours |
| Reinforcing | Experiential activity | 5 hours |

The activity consists of the development of a software project, following a scope defined by the professor, who plays the role of the customer in the project. The scope of each project was designed to be challenging and different for each team, aiming to show the diversity of situations in different projects. The scope proposed was a solution that would allow parents to register the evolution of their children using a web app, involving vaccine calendar, weight and height monitoring, health history and highlight moments.

Specifically, for the activities of planning schedule, resources, human resources, and costs, we used, as support, the educational game ThatPMGame [*20*]. The game consists of the simulation of resource allocation in a fictional virtual project, in which the player must analyze the best strategy to meet the time and cost constraints of the project. To boost the activity, we created teams and playing rounds, in which the students played in front of the class by using a multimedia projector, similarly to the Dojo Randori style [*25*]. We created rules for scoring the teams. Once all the participants have played, the final score of each team was known and the champion was revealed.

In the risk management knowledge area, we used the educational game "RiskGame" [*21*], based on a virtual game, but adapted for use in a non-digital way. The game is a board game simulating a project, where in some places of the board positive or negative events for the project may occur. Whereas the progress of the game happens by playing dices, students must analyze risk probability and impact and plan or not preventive actions based on this scenario. The professor simulates the execution of the project and each group simulates their own scenario, to ascertain the most effective measures. In the end, the results and strategies adopted are discussed.

In the implementation phase of the project, groups are free to use the technologies and processes that they find more suitable, subjected to compliance with the process and the proposed activities for the management of the project. 36 hours were used for the execution of the project in the classroom, where students could develop the product and ask questions with the teacher (who played the role of the customer). Although it was not mandatory, students worked many hours on the project outside the classroom. In the end, each group presented the software project developed.

Finally, in the last phase of the course, we conducted the experiential activity PizzaMia [*19*], in which students had to carry out a project that involved the preparation of a lunch based on pizzas, including the purchase of materials, meal preparation, setting the location, artistic attraction, cleaning, etc. The entire process was conducted following the phases and activities of the PMBOK, with document templates and restrictions imposed. This activity aimed to review, in a fast and dynamic way, all the PM concepts presented previously, besides performing, in a real project, all these steps, even if it is not an example of software development. An instructional methods overview is showed in Fig. 3.

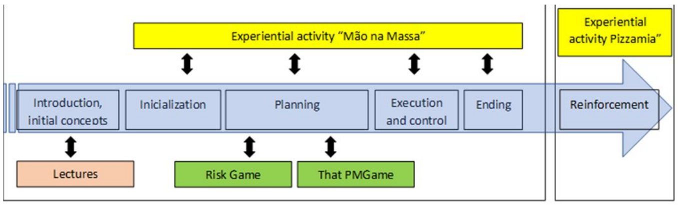



Fig. 3: Instructional methods schema

## V. RESULTS

We applied the MEEGA evaluation model [*22*] for each of the ThatPMGame, RiskGame PizzaMia activities, including motivation, user experience, and learning. For the Mão na Massa activity, we used an evaluation method based on MEEGA and model proposed by [*23*], and to evaluate learning we adapt part of the MEEGA evaluation model. The ratings of all classes were grouped to allow analyzing the big picture.

Below we describe the results of each activity, as well as the assessment of the course graduates.

### A. *ThatPMGame*

Table III shows the results of the evaluation for each aspect of the MEEGA model considering the educational game *ThatPMGame*.

TABLE III. EVALUATION RESULTS OF THE THATPMGAME EXECUTION

| **Evaluation** | *+2* | *+1* | *0* | *-1* | *-2* |
|---|---|---|---|---|---|
| Motivation | 51.3% | 37.4% | 9.0% | 2.3% | 0.0% |
| User Experience | 54.9% | 32.4% | 10.0% | 2.7% | 0.0% |
| Learning | 39.8% | 40.9% | 17.2% | 2.1% | 0.0% |

We can see that more than 80% of responses were positive for all aspects (sum of answers "1" and "2"), especially for motivation (88,7%) and user experience (87,3%). A key point here is that more than 50% of the students evaluate the motivation and the user experience as VERY GOOD. Analyzing learning in more detail, Fig. 4 shows an evaluation of the students' knowledge in each of the five contents asked, before and after performing the activity.

We can notice that there has been a significant improvement in perceived knowledge (average before = 2.2 and average after = 3.9), resulting in *p*-value = $1.471\times10^{-6}$ by applying the *t*-test. Results are similar in the five contents assessed: activity sequencing (*p-value* = $1.863\times10^{-9}$), resource planning (*p-value* = $5.597\times10^{-9}$), earned value management (EVM) (*p-value* = $5,158\times10^{-9}$), cost planning (*p-value* = $2,635\times10^{-9}$), and schedule development (*p-value* = $1,357\times10^{-10}$). A less significant evolution in the EVM content can be attributed to the fact that the game does not explore directly this concept, but rather implicitly.


Fig. 4. Learning Evaluation of *ThatPMGame* execution

### B. *PizzaMia*

The results of the evaluation showed that the *PizzaMia* activity had high approval ratings by students, both in motivation and user experience aspects (more than 90% approval), as in the evolution of learning (about 98%), as shown in Table IV.

TABLE IV. EVALUATION RESULTS OF THE PIZZAMIA EXECUTION

| **Evaluation** | *+2* | *+1* | *0* | *-1* | *-2* |
|---|---|---|---|---|---|
| Motivation | 71.0% | 22.0% | 5.5% | 1.5% | 0.0% |
| User Experience | 77.6% | 16.2% | 4.8% | 1.5% | 0.0% |
| Learning | 68.0% | 30.6% | 1.4% | 0.0% | 0.0% |

Table V shows the evaluation of the students' feeling about the learning evolution at the cognitive level of the application based on Bloom's taxonomy [*26*], before and after performing the activity.

TABLE V. LEARNING EVALUATION OF *PIZZAMIA*

| **Content** | **Learning (application)** | | |
|---|---|---|---|
| | ***Before*** | ***After*** | ***Diff.*** |
| Project initiating | 2,02 | 3,20 | 1,18 |
| Scope management | 2,07 | 3,16 | 1,09 |
| Cost management | 2,23 | 3,31 | 1,07 |
| Time management | 2,29 | 3,41 | 1,12 |
| Quality management | 2,21 | 3,21 | 1,00 |
| Risk management | 2,06 | 3,17 | 1,11 |
| Communication management | 2,08 | 3,14 | 1,06 |
| Resources management | 2,13 | 3,08 | 0,95 |
| Stakeholders management | 2,11 | 3,12 | 1,01 |
| Acquisition management | 2,09 | 3,05 | 0,96 |
| Integration | 2,05 | 3,10 | 1,05 |
| Monitoring and controlling | 1,95 | 3,09 | 1,14 |
| Closing and learned lessons learned | 2,21 | 3,29 | 1,07 |
| Total | 2,12 | 3,18 | 1,06 |

By applying the *t*-test to assess the overall difference of the averages, we obtained $t = -80.202$, $df = 11$ and *p*-value < 8.8×10-16. For all topics the *p*-value obtained was less than 0.01, proving, therefore, the significant difference between assessments before and after the activity.

This result is important because it highlights the broad scope of the activity that encompasses the entire PM process and areas, unlike many other existing educational approaches [*27*] [*28*] [*29*] [*30*].

### C. *Mão na Massa*

The students answered a questionnaire for evaluation of experiential activities [*23*]. The results were very positive with respect to the participant's perception in relation to the activity (over 95% of positive responses), as shown in Fig. 5.

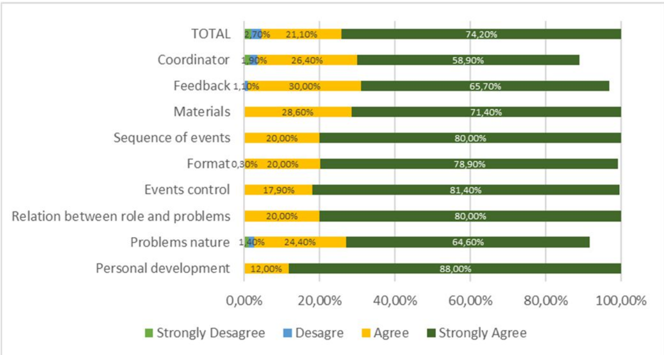



Fig. 5: Evaluation results of the *Mão na Massa* execution

Similarly, the evolution of learning perception of students was significant (Table VI). On a scale of 1 to 5, the average evolution described was 2.06 (1.86 to 3.92). Applying the *t*-test resulted in $t = -44.944$, $df = 13$, *p-value* $= 1.19\times10^{-15}$, proving a significant difference between the level of knowledge before and after the activity execution.

TABLE VI. LEARNING EVALUATION OF *MÃO NA MASSA*

| **Concepts** | **Apply in practice** | | |
|---|---|---|---|
| | ***Before*** | ***After*** | ***Diff.*** |
| Project initiating | 1,60 | 3,89 | 2,29 |
| Scope planning | 1,86 | 4,03 | 2,17 |
| Schedule planning | 1,97 | 4,11 | 2,14 |
| Cost planning | 1,49 | 3,63 | 2,14 |
| Quality planning | 1,86 | 3,69 | 1,83 |
| Risk planning | 1,51 | 3,89 | 2,37 |
| Human resources planning | 1,54 | 3,40 | 1,86 |
| Stakeholders planning | 1,60 | 3,66 | 2,06 |
| Acquisition planning | 1,54 | 3,54 | 2,00 |
| Integration planning | 1,37 | 3,29 | 1,91 |
| Communication planning | 1,60 | 3,71 | 2,11 |
| Executing management | 1,74 | 3,94 | 2,20 |
| Monitoring and controlling | 1,83 | 4,06 | 2,23 |
| Project closing | 1,63 | 4,03 | 2,40 |

A significant improvement in learning is perceived, with emphasis on some underexplored topics in teaching PM, such as risk planning, closing, monitoring and controlling, and initiating. Comparing with the results of the experiential activity *PizzaMia*, the best results are noted with respect to learning, considering the cognitive level of application. This can be explained by the fact that the *Mão na Massa* activity is more extensive, held during a longer time, with a real project, while the *PizzaMia* is intended to be an activity to consolidate and revise the knowledge acquired, by using a project outside the software development area.

### D. *Risk Game*

We can see in Fig. 6 that more than 70% of responses were positive for all aspects, with emphasis on motivation. Analyzing learning in more detail, Fig. 6 shows an evaluation of the students' knowledge in each of the three topics, before and after performing the activity. Applying the *t*-test we obtained, $t = -34.641$, $df = 2$, *p-value* $= 0.0008323$, proving a significant difference on the perception of learning.

TABLE VII. EVALUATION RESULTS OF THE RISKGAME EXECUTION

| **Evaluation** | **+2** | **+1** | **0** | **-1** | **-2** |
|---|---|---|---|---|---|
| Motivation | 38.4% | 47.2% | 10.6% | 2.2% | 1.5% |
| User Experience | 33.0% | 38.6% | 23.9% | 3.8% | 0.7% |
| Learning | 36.5% | 44.8% | 16.7% | 2.1% | 0.0% |

Despite the motivation and user experience did not have results as positive as the other approaches, the perception of learning evolution was significant to related concepts: before the game students reported an average of 1.8, and 3.8 after the game (Fig. 6).

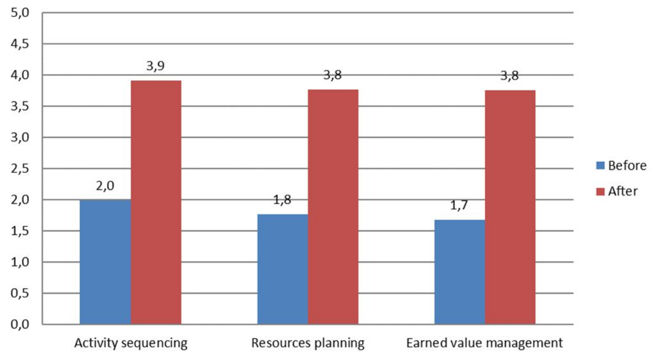



Fig. 6. Learning evaluation of *RiskGame* execution.

### E. *Evaluation with graduates*

To check the impact of the approaches used in the course over time, we sent a questionnaire[2] by email, which was answered by 44 of the 63 students, reaching a participation rate of 74.2%. Except for those described as "descriptive", all other questions have five options for an answer on a Likert scale (values from -2 to +2. We created 22 items in the questionnaire related to the PM teaching-learning process to answer following questions:

*a) Relate the concepts, techniques, practices, or new methods you have learned in the course and still use nowadays or have knowledge about (descriptive);*

[2] Available on website https://goo.gl/KYU1mJ

*b) Rate each of the teaching methods that help you to learn more and retain knowledge;*

*c) What were the benefits you had with the course?*

*d) What are the activities/dynamics that you remember from the course of project management? (descriptive);*

*e) What knowledge and importance you give to "project management" before the course and now?*

*f) Assign a rating to each kind of teaching-learning approach used according to its role in motivation (how much was as the activity important to keep the interest in the course);*

*g) Assign a rating to each kind of teaching-learning approach used according to its importance in learning (how much does the activity contribute to the improvement of knowledge and skills);*

*h) In your opinion, what is the impact of each factor on the student's motivation to continue engaged in a course/program in software engineering?*

The internal consistency of the questionnaire was evaluated by calculating the Cronbach's Alpha coefficient, whose result was 0.9054. "There are different reports about the acceptable values of alpha, ranging from 0.70 to 0.95" [*24*].

We also analyzed the Cronbach's alpha if an item is removed. As expected no item caused a substantial decrease in the Cronbach's alpha [*27*]. Additionally, we analyze the item-total correlation. In general, the correlations are medium to high considering reference values as defined by [*29*], considering a correlation satisfactorily if the correlation coefficient is greater than 0.29, indicating evidence of validity. Only one item (Evaluation of learning method “practical exercises in class”) had item-total correlation significantly lower (0.169).

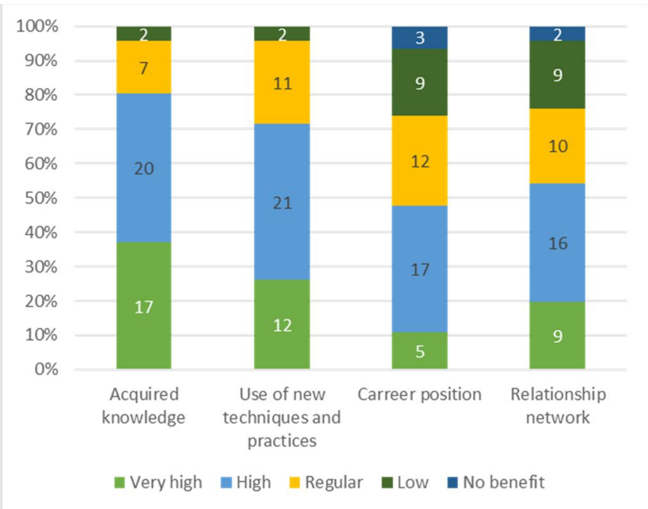



Fig. 7. Program benefits on the graduates' view

Two questions were broader to help identify the students' profile and the impact of the course on their professional career. Fig. 7 shows that the main benefits obtained were the knowledge acquired and the practical application of what was learned. However, benefits on the career and networking were also cited by most students.

In Fig. 8 we can see that almost all students have changed the way they work due to knowledge acquired in the course, using some or several new techniques, practices or methods in their companies. The scatter plot presented in Fig. 9 shows the difference between the positive, negative, and neutral ratings of each teaching-learning method. For example, dynamics and educational games (approach 6) had a most positive evaluation, comparing to others. Students' preference is for: dynamics and educational games, group practical activities, group theoretical activities, and individual practical exercises, respectively.

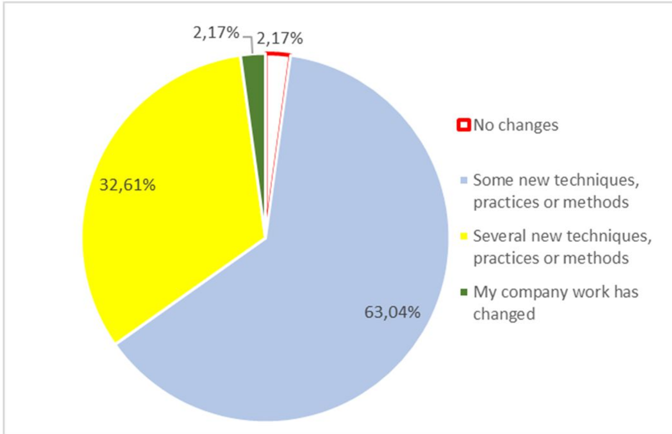
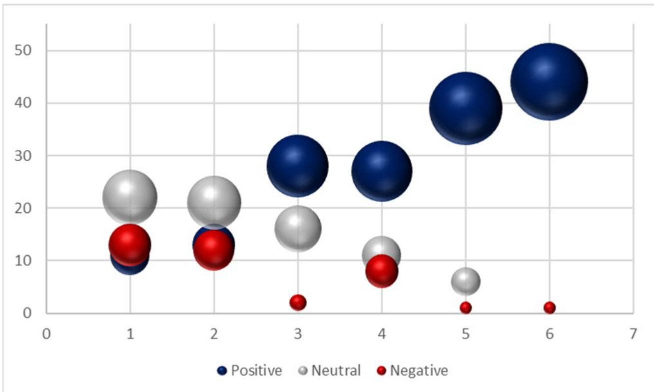



Fig. 8. Changes in graduates' working




1. Lecture, 2. Individual theoretical exercises, 3. Individual practical exercises, 4. Group theoretical activities 5. Group practical activities 6. Dynamics and educational games.

Fig. 9. Teaching approaches evaluation by graduates

To analyze if the difference among categories is significant we used Pearson's Chi-squared test, whose results ($X$-squared = 85.261, $df$ = 10, $p$-value = $4.637\times10^{-14}$) proved that the categories have significant differences.

As for knowledge (Fig. 10), the difference between before and after attending the course was expressive, showed by the result of the $t$-test, $t = -9.9267$, $df = 45$, $p$-value = $6.544\times10^{-13}$.

Students reported having changed the perception of knowledge and importance of PM in software development, as shown in Fig. 11. Related to the perception of PM importance (Fig. 11), we also apply the $t$-test to compare the results before and after attending the course and proved a significant difference, $t$ = -6.951, $df$ = 45, $p$-value = $1.20 \times 10^{-8}$.

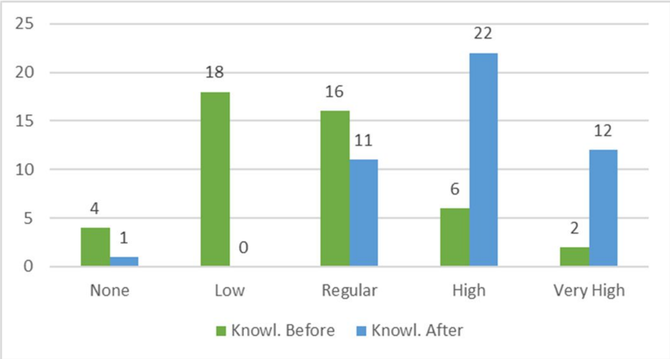



Fig. 10: Graduates' learning improvement

We asked, in an open question, which concepts, techniques, or activities carried out in the PM course students still remember. Of the 44 students who answered the questionnaire, 38 answered this question. Of these, 33 have cited activities related to the teaching-learning practices used, 30 of which have cited the PizzaMia activity, 5 cited the Mão na Massa activity and one still cited the group activities or dynamics activities in a general way.

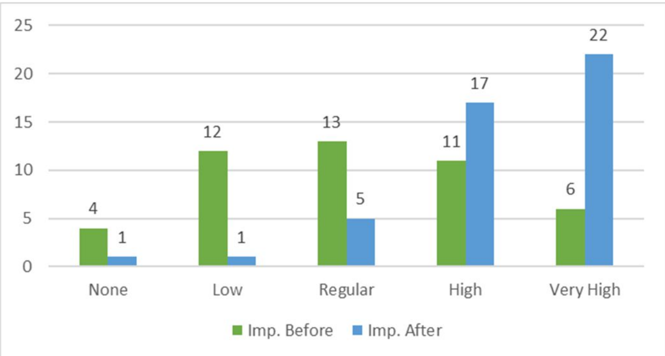



Fig. 11: Perception of PM importance

To compare the initial assessment with the perception of the graduated student over time, students were asked how each activity, in their opinion, assisted in motivation and learning during the course.

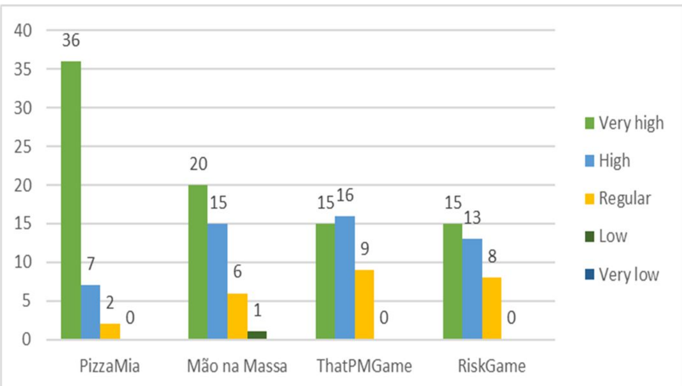



Fig. 12: Graduates' evaluation of teaching approaches

Fig. 12 shows that the *PizzaMia* activity had a greater impact on motivation, although all activities have had a positive assessment.

As for learning, we can see that graduated students evaluated all activities positively, as shown in Fig. 13, with similar intensity to *PizzaMia* and *Mão na Massa*.

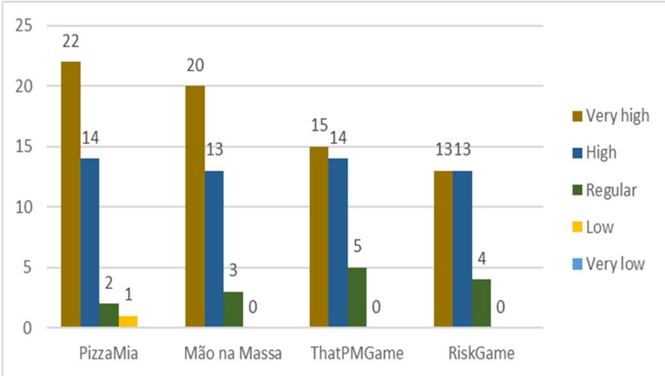



Fig. 13: Graduates' evaluation for teaching-learning approaches

Table VIII shows the comparison of each educational approach results with the other, using $t$-test for paired data. We could not see evidence of significant differences between "individual theoretical exercises" and "lectures", as well as between "individual practical exercises" and "group theoretical activities". For all other correlations, we found significant differences.

To calculate motivation and learning it was used the average of the "motivation" and "learning" constructors from the MEEGA model. For the *Mão na Massa* activity, which we did not use the MEEGA model, learning was calculated as the average of the learning values of each topic/subject.

TABLE VIII. TEACHING-LEARNING STRATEGIES COMPARISON (P-VALUE)

| **Teaching approach** | **1** | **2** | **3** | **4** | **5** |
|---|---|---|---|---|---|
| 1. Lectures | - | | | | |
| 2. Individual theoretical exercises | 0.537 | - | | | |
| 3.Individual practical exercises | $1.7e^{-7}$ | $3.1e^{-7}$ | - | | |
| 4. Group theoretical activities | 0.0002 | 0.0009 | 0.0832 | - | |
| 5. Group practical activities | $1.9e^{-11}$ | $1.8e^{-10}$ | 0.0040 | $3.43e^{-6}$ | - |
| 6. Dynamic/educational games | $4.6e^{-15}$ | $5.0e^{-14}$ | $3.10e^{-6}$ | $3.6e^{-11}$ | 0.000 |

TABLE IX. COMPARISON BETWEEN LONGITUDINAL EVALUATIONS

| **Activity**[a] | **Motivation Stage 1** | **Motivation Stage 2** | **Learning Stage 1** | **Learning Stage 2** |
|---|---|---|---|---|
| PizzaMia | 1.6204 | 1.7556 | 1.6667 | 1.5366 |
| Mão na Massa | NE | 1.2857 | 1.5106 | 1.5366 |
| ThatPMGame | 1.3742 | 1.1500 | 1.1828 | 1.3590 |
| RiskGame | 1.2258 | 1.1389 | 1.1935 | 1.3429 |

a. NE – not evaluated

In order to assess the changing of evaluations before and after the execution of each teaching-learning activity, we performed a comparison that can be seen in Table IX.

We can verify in Table IX that there were small variations between the assessments at each stage. Nevertheless, it has not been possible to prove any significant difference between variations in motivation ($p = 0.6316$) and learning ($p = 0.4865$). That is a sign that students remember and continue to give importance to the active teaching and learning approaches, even after years.

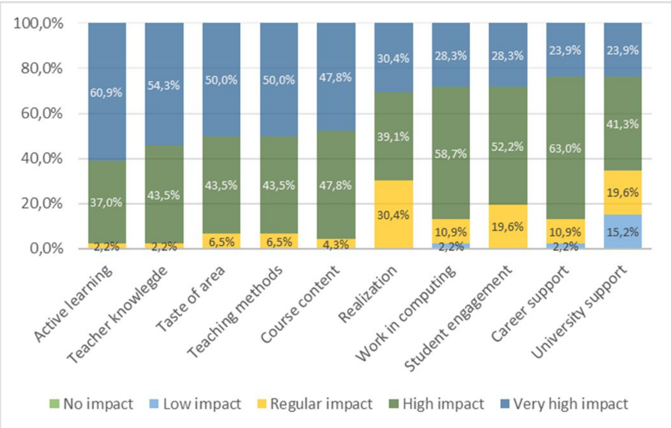



Fig. 14: Evaluation of teaching-learning methods

Asked about the importance of certain factors in motivation to continue attending a course in software engineering, most students ranked several factors as important, but the most prominent were: a practical approach, teacher's knowledge, didactics, and taste for the area. These four factors obtained more than 90% of positive responses, as shown in Fig. 14.

## VI. DISCUSSION AND CONCLUSION

This article showed a case study describing the use of a mixed teaching and learning approach for a PM course in a software engineering program and the students' perception about teaching strategies. The study showed a set of four different instructional methods: hands-on, digital game, non-digital game, and experiential activity.

The results of the students' evaluation showed a positive rating of the isolated methods, with emphasis on practical activities (hands-on and experiential). In addition, we verified that the contents and activities most remembered, even after an extended period, are related to these activities.

TABLE X. COMPARISON BETWEEN LONGITUDINAL EVALUATIONS

| **Criteria** [a] | **This work** | **Hussein [15]** | **Ibrahim [3]** |
|---|---|---|---|
| Educational games and hands-on activities | 94,4% | 84,3% | 85,0% |
| Lectures | 59,6% | 85,2% | NE[b] |
| Exercises | 73,2% | 81,3% | NE[b] |

a. Percent of positive evaluation

b. NE – not evaluated

Comparing the instructional methods evaluation to other studies, we obtain a good evaluation of games and experiential activities and not so good evaluation about lectures and exercises. This indicates the efficacy of active learning methods presented.

We defined and validated an instrument to evaluate the perception of graduated students about the learning and motivation of instructional methods used. The entire questionnaire is available on the website <<omitted for blind review>> and can be used for other researchers.

We confirmed also that graduated students realize active and group instructional methods as more efficient for both learning and motivation to attend the course. Besides the intrinsic motivation, as in several other studies [*31*] [*32*] [*33*], graduated students still consider that the most important aspects for motivation in software engineering are: a practical approach, didactics, course format and professor's knowledge. Another important aspect was the high rate of students who indicated that career and position in the work market as very important factors for motivation. We notice further that there was no significant variation between the temporal samples, showing that perception of learning and motivation remain similar even after years.

Our perception is that students' motivation and learning improve with practical activities, especially educational games and experiential activities. But, we have perceived that there are some important conditions to create more successful activities: i) they must be planned in the entire context of instructional unit, taking into account the learning goals; ii) they work better if combined with other strategies, as a complementary method to teach or reinforce some content; iii) the student's attention and motivation increase when the activities have some competition aspects, such as ranking, challenges, recompenses, etc.; and iv) if it is possible, they have to be fun.

Whereas the motivation is a factor strongly related to student retention and performance [*34*] [*35*] [*36*] [*37*], the results of this study show the importance to consider mixed approaches, with an emphasis on active and practice instructional methods to improve the motivation and learning of students in PM.

There are some threats to the validity of this research: i) the limited number of participants; ii) the fact that it is a case study in a single course of a single university, and other factors that have impacted on the results may not have been considered in the study; iii) the fact that different models were used for different assessment approaches presents a risk in some comparisons carried out; and iv) student self-assessment allows bias in responses according to the student's current state of mind. The first three threats are limitations of this work, while to reduce the impact of the fourth, an evaluation was carried out later with graduates, allowing to compare some indicators in different moments.

Therefore, it is important to conduct more studies in other contexts, addressing other universities, courses, and programs.

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