How to Teach the Usage of Project Management Tools in Computer Courses

A Systematic Literature Review

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***Abstract*—Project management tools are mandatory to properly manage a software project. The teaching of these tools is carried out in superior computer courses, but often the instructional strategies are used in an ad-hoc manner. This study aims to analyze the literature about teaching of the usage of project management tools and to identify the instructional strategies and the utilized tools. We conducted a systematic literature review to identify the most significant studies that report experiences on this context. After analyzing more than 2700 studies a total of 5 primary studies were selected, and then others were manually included. The instructional strategies and the utilized tools are presented, highlighting the main functionalities and educational features of these tools, as well as the instructional activities carried out to meet the educational goals. Concluding with a discussion of the advances and gaps that remain in this area.**

Keywords-Project Management; Project Management Tools; PMBOK; Systematic Literature Review; Teaching; Education.

I. INTRODUCTION

Project Management (PM) is a critical area for many organizations in the software industry. A significant amount of projects still fail due to a lack of proper management, causing problems related to unaccomplished deadlines, budget overrun, or scope coverage [1]. In this context a project is considered a temporary endeavor to achieve a single result, and PM is the use of knowledge, abilities, tools, and techniques that enable a project to reach its goals [2].

Projects problems occur mainly because of the absence of a PM process [3], resulting in a limited control over project restrictions, resources, and stakeholders [1]. The adoption of a PM process may be facilitated by the usage of a PM tool [4]. Despite many organizations still not using any PM tool, the positive contributions that these tools have brought about have increased the interest in their use [5].

The responsibility for the usage of these tools lies with the project manager, who is accountable for the success of the project, having the authority to direct its resources in order to conduct the project in a systematic PM process [2].

Given that the usage of PM tools is not well rooted in organizations, and that projects still fail, a possible cause for this could be the teaching of project managers [1, 6, 7].

The teaching of PM has to addresses the knowledge on PM, beyond general knowledge on administration, project environment and application area, and interpersonal abilities [2]. However, the teaching of PM should not just be focused on theoretical knowledge, because it is not enough to effectively apply the PM. It is necessary to develop the project manager competencies, which include knowledge (theoretical), abilities (practical), and attitudes (proactivity) [8]. In addition to this, due to the complexity of contemporary software projects, the PM is impracticable without the support of a PM tool, and the usage of these tools is also among the project manager competencies [4]. A PM tool is a software that supports the whole PM process. Among its supported functionalities are: schedule development, resources allocation, monitoring of project performance, etc. [7].

The contribution of this research is the identification of strategies that have been used to teach the usage of PM tools, as well as, the tools adopted. These results may assist teachers in the teaching of this topic, and also assist researchers in the improvement of these strategies by the identification of advances and gaps that remain in this area.

II. BACKGROUND

A. Project Management

The PM conducts the project activities and resources to meet its requirements, since its initiating to its closing (Fig. 1).

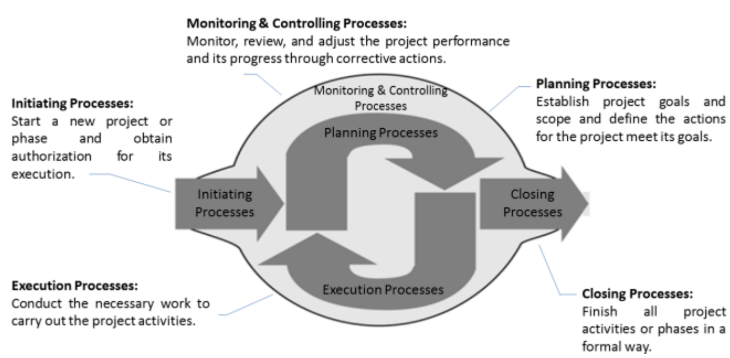

Figure 1. PM processes groups [2].

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Orthogonally to these process groups, the PM processes are organized in 10 knowledge areas (Table 1).

Table 1. PM knowledge areas [2].

Knowledge area	Processes to:
Integration	Identify, define, combine, unify, and coordinate PM processes and PM activities.
Scope	Ensure that the project addresses the entire work and meets all its requirements.
Time	Plan, monitor and control the activities that will be carried out during the project so it concludes within the deadline.
Cost	Plan, estimate, and control project costs, so it concludes within the approved budget.
Quality	Define the responsibilities, goals, and quality policies so the project meets the needs that have initiated it.
HR	Organize and manage the project team.
Communication	Ensure the generation, collection, distribution, storage, recovery, and final destination of project information.
Risk	Identify, monitor and control the project risks.
Acquisition	Buy or contract products, services or any resources that are not available as project internal resources.
Stakeholder	Identify and manage the stakeholders and its expectations.

B. *PM Tools*

A PM tool is a software that supports the whole PM process. Among its supported functionalities are: schedule development, resources allocation, monitoring of project performance, and other functionalities that may support any of PM knowledge areas [4, 7].

Today, there are many PM tools available [9]. These tools are typically classified according to its availability: proprietary (the use of a license or acquisition is mandatory, and it is maintained exclusively by an organization) or open-source (free usage and maintained by the users community). The most relevant proprietary PM tools are: MS-Project (microsoft.com/project) and Primavera (oracle.com/primavera) [4]. Some of most relevant open-source PM tools are: DotProject (dotproject.net), Project.net (project.net), and PhpCollab (phpcollab.com) [10]. The tools also may be distinct by its platform, namely: stand-alone (single user and accessed via desktop) or web-based (multi user and accessed via web browser). Their supported functionalities also vary significantly and may have different approaches, for instance, it may support the whole PM process, just a knowledge area, or, more specifically, just a few activities, as the tracking of worked hours [11].

C. *Teaching of PM Tools*

The usage of PM tools is part of the project manager competencies [2]. The need of Instructional Units (IUs) for teaching this competency is addressed by the ACM/IEEE reference curriculum for Computer Science [12]. It specifies that students have to develop knowledge in all PM knowledge areas, and have to learn the usage of a PM tool to develop a project schedule, allocate resources, monitor the project activities, etc. Based on these educational needs it is inferred that the usage of a PM tool has to be taught in the application level of the Bloom taxonomy (Table 2), once the knowledge on PM have to be applied through the usage of a PM tool.

Table 2. Bloom taxonomy levels [13].

Level	Refers to the students ability to:
Knowledge	Identify or define some specific information based on previous learning events.
Comprehension	Demonstrate the understanding of an information, and being able to reproduce it by ideas and own words.
Application	Recognize and apply the information to solve concrete problems.
Analysis	Structure the information, fragmenting its parts and establishing their relations and explaining it.
Synthesis	Collect and relate information from various sources, creating a new product.
Evaluation	Make judgments about the value of something (products, ideas, etc.), in relation to known criteria.

Often techniques taught in these IUs include [2, 7, 9]: the Critical Path Method (CPM) – that identifies the project activities that cannot be delayed without affecting the project deadline; the Program Evaluation and Review Technique (PERT) – that calculates the estimated effort to carry out an activity based on three other estimates (worst case, most common case, and best case); the RACI Matrix - describes the participation by various roles in completing project activities; the Resources Levelling - technique in which start and finish dates are adjusted based on resource constraints, with the goal of balancing demand for resources with the available supply; amongst others. To teach these competencies some instructional strategies (Table 3) may be adopted.

Table 3. Instructional strategies.

Instructional Strategy	Description
Direct Instruction	The teacher transmits concepts to students through expositive classes.
Indirect Instruction	The students carry out activities by themselves, and the teacher provides feedback when necessary.
Interactive Instruction	Based on the discussion and sharing of ideas among the students. The teacher acts as a mediator.
Independent Study	Refers to methods which are purposefully provided to foster the development of individual student initiative.
Experimental Learning	Student-centered and oriented to activities. It involves the application of concepts in practical situations.

These IUs also have to evaluate the students learning, and then different kinds of evaluations levels may be adopted (Table 4).

Table 4. Four-level model for evaluation [14].

Level	Evaluation Level	Evaluation description and characteristics
1	Reaction	Evaluates how the participants felt about the training or learning experience.
2	Learning	Evaluates the increase in knowledge or skills.
3	Behavior	Evaluates the degree to which new learning acquired actually transfers to the job performance.
4	Results	Evaluation of the effect on the business environment by the learner.

III. DEFINITION OF SYSTEMATIC LITERATURE REVIEW

The methodology to conduct this research is the Systematic Literature Review (SLR) following the method defined in [15]. A SLR is a study to identify, evaluate and interpret the studies that are available and that are relevant to some research question [15].

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A. Research Question

This research aims to identify how to teach the usage of PM tools in superior computer courses. Based on this motivation, we performed a SLR focusing on three research questions:

a) RQ1: Which PM tools are taught in superior computer courses?

b) RQ2: Which instructional strategies are used to teach PM tools in superior computer courses?

c) RQ3: How the instructional strategies effectiveness has been evaluated?

B. Inclusion/Exclusion Criteria

Aiming to select only significant studies, criteria for including/excluding such studies were defined. It had been selected just studies related to the teaching of PM tools, which were published in English language, that are available in digital libraries, and that were published between January 2004 and June 2014. Other criteria restrict the search just for studies that had passed by a peer review process, be it journals or conference proceedings papers. In addition it was excluded: i) Any study that does not use a PM tool (e.g. games, simulators, and e-learning software); ii) Any study that explicitly does not focus on PMBOK (e.g. agile methodologies or other PM approaches), because it is the main reference in area and worldwide accepted [4]; and iii) Any study external to the computer area.

C. Data Sources and Keywords

The data sources had been chosen based on its relevance in software engineering domain, namely: ACM Digital Library, IEEEXplore, ScienceDirect, Scopus, SpringerLink, and Wiley online library. The keywords were defined based on the concepts in the SLR research questions (Table 5).

Table 5. Keywords.

Concept	Keyword and synonymous
Education	Education, teaching, and learning
Project Management	Project management and PMBOK
Tool	Tool, software, and system

IV. SLR EXECUTION

The SLR had been carried out in June 2014. It was conducted by first author, a Computer Science PhD candidate, and it had been reviewed by a senior researcher. The Table 6 presents the amount of returned results by each data source.

Table 6. Returned results by data sources.

Data source	Results
ACM Digital Library (http://dl.acm.org/)	275
IEEEXplore (http://ieeexplore.ieee.org)	1,078
ScienceDirect (www.sciencedirect.com)	65
Scopus (www.scopus.com)	662
SpringerLink (www.springerlink.com)	537
Wiley online library (onlinelibrary.wiley.com)	140
Total	**2,757**

The returned studies were first analyzed just by their title. The abstract was read only in cases that the titles did not provide evidence of any exclusion criteria. The content of the study was analyzed only in doubtful cases, for instance, when it was not clear if it was used a PM tool or a simulator. Most studies were excluded because they did not report the usage of any PM tool, but other software (games, e-learning, simulators, etc.). Many other studies were excluded because they are not related to computer area. At the end, just 5 relevant studies were selected (Table 7).

Table 7. Selected studies.

ID	Reference
S1	K. Reid, and G. Wilson, “DrProject: A Software Project Management Portal to Meet Educational Needs,”. In: Proc. of the Special Interest Group on Computer Science Education, Covington, 2007.
S2	Ž. Car, H. Belani, and K. Pripužić, “Teaching Project Management in Academic ICT Environments,” In: Proc. of the Int. Conf. on “Computer as a Tool”,Warsaw, 2007.
S3	G. Gregoriou, K.Kirytopoulos, and C. Kiriklidis, “Project Management Educational Software (ProMES),” Computer Applications in Engineering Education, vol. 21, n. 1, pp. 46–59, 2010.
S4	S. BHATTACHARYA, “Cooperative learning and website in Software Project Management pedagogy,” In: Proc. of the Int. Conf. on Interactive Collaborative Learning, Kazan, 2013.
S5	L. Salas-Morera, A. Arauzo-Azofra, and L. García-Hernández, “PpcProject: An educational tool for software project management,” Computers & Education, vol. 69, n.1, pp. 181–188, 2013.

Aiming to find more relevant studies, the state of the art section of the selected studies was analyzed, and 3 more relevant studies were found. Although some of these presented tools did include simulation/game features, when analyzing their functionalities it became evident that they may in fact be characterized as PM tools.

Table 8. Manually included studies.

ID	Reference
S6	A. Shtub, “Project management simulation with PTB project team builder,” In: Proc. of the 2010 Winter Simulation Conference, Baltimore, 2010.
S7	F. Deblaere, E. Demeulemeester, and W. Herroelen, “RESCON: Educational Project Scheduling Software,” Computer Applications in Engineering Education,” vol. 19, n. 1, pp. 327-336, 2009.
S8	M. Vanhoucke, V. Vereecke, and P. Gemmel, “The Project Scheduling Game,” Project Management Journal, vol. 36, n. 1, pp. 51-59, 2005.

V. DATA SYNTHESIS AND EXTRACTION

After selecting the studies, their data were systematically extracted. The metadata to be extracted from studies were defined based on each research question:

a) RQ1: tool name, classification (availability (proprietary or open-source), platform (desktop or web-based) and propose (general usage or educational)), main functionalities, educational features, print screen.

b) RQ2: addressed process groups and knowledge areas, educational goals, taught functionalities, instructional strategies and activities, students evaluation method, discipline hours.

c) RQ3: evaluation goals, instrument for data collection, sample size, evaluation method and evaluation level.

Firstly, the general features of PM tools are presented in Table 9. As the studies itself do not necessarily indicate these information explicitly, some of the information has been inferred based on the presented reports.

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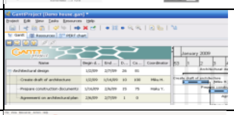
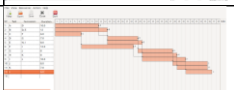
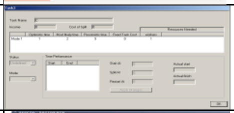
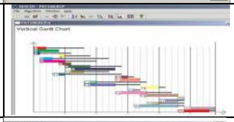
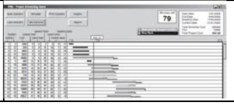
Table 9. General features of PM tools (RQ1).

ID	Tool name	Classifications	Main functionalities	Educational features	Print screen
S1	DrProject	Open-source, web-based and educational.	Tickets creation (analogue to project activities creation and human resources allocation), mailing lists for project communication, and wiki for organizing the project documentation.	-Mailing lists to facilitate the project communication between team members and the teacher. -The forms contain only the strictly necessary fields in the context of the discipline.	
S2	MS-Project	Proprietary, desktop, and general usage.	Schedule development, project team definition, hour/rate configuration for human resources, project progress update and monitoring, baselines control.	Does not apply.	
S3	ProMES	Open-source, desktop, and educational.	Supports the application of CPM, PERT, and RACI matrix techniques.	-Provides scenarios and difficult levels to apply the CPM, PERT, and RACI matrix techniques. -Configuration of experience levels: trainee (student has support of the tool) and professional (no help is provided), and tutorial video.	
S4	Gantt project	Open-source, desktop, and general usage.	Schedule development, project progress updating and monitoring.	Does not apply.	
S5	PpcProject	PpcProject: Open-source, desktop and educational.	Schedule development, support the CPM, PERT, and resources levelling techniques.	The historic of all calculi are maintained on screen for the student follow the calculation procedure.	
S6	Project Team Builder - PTB	Proprietary, desktop, and educational.	Work packages definition, schedule development, and effort, resources, and cost estimations.	Provides scenarios to simulate the execution of a project plan, requiring the students to take decisions which respect the project restrictions.	
S7	RESCON	Open-source, desktop, and educational.	Schedule development, resources allocation, and CPM.	- What-if analysis for the students evaluating the effects of resources inclusion in the project. - Simulation of different schedule development algorithms that solve resource constraint problems.	
S8	Project Scheduling Game – PSG	Proprietary, desktop, and educational.	Schedule development, resources allocation, cost planning, and CPM.	Simulation of project execution requiring the students to take decisions regarding the time/cost trade-off.	

Information related to the instructional strategies for teaching of PM tools usage (RQ2) are presented in Table 10. As the studies itself do not necessarily indicate these information explicitly, some of the information has been inferred based on the presented reports.

Table 10. Data related to the instruction strategies (RQ2).

ID	Process groups	Knowledge areas	Educational goals	Taught functionalities	Instructional strategies and activities	Students evaluation method	Discipline hours
S1	Initiation, Planning, Execution, Monitoring & Controlling, Closing.	Time, HR, and communication.	After the classes about PM tool usage the students have to use a PM tool to setup a project, create its plan, and keep its progress updated while executing it.	Schedule development, organization of documentation, project communication.	**Classification:** Experimental Learning **Activities:** Elaboration of a project plan using a PM tool, and execution of the planned project in groups of students.	Not informed	Not informed. *It had 7 weeks of duration.
S2	Initiation, Planning, Execution, Monitoring & Controlling, Closing.	Time, HR, and communication.	After the classes about PM tool usage the students have to use a PM tool to setup a project, create its plan, and keep its progress updated while executing it.	Schedule development and monitoring.	**Classification:** Experimental Learning **Activities:** Elaboration of a project plan using a PM tool, execution of the planned project in groups of students, and production of project artefacts during its life cycle.	-Delivery of exercise carried out using the PM tool. -Theoretical test of objective questions.	Not informed *It had 7 weeks of duration.
S3	Planning	Time, and HR.	After the classes about PM tool usage the students have to use a PM tool to apply the CPM, PERT, and RACI matrix techniques.	PERT, CPM and RACI matrix techniques.	**Classification:** Experimental Learning **Activities:** Resolution of problems using CPM, PERT, RACI matrix techniques. For each technique are carried out exercises with ascending difficulty level.	Delivery of problems resolution.	Not informed
S4	Initiation, Planning, Execution, Monitoring & Controlling, Closing.	Scope, time, and HR.	After the classes about PM tool usage the students have to use a PM tool to setup a project, create its plan, and keep its progress updated while executing it.	Schedule development.	**Classification:** Experimental Learning **Activities:** Elaboration of a project plan using a PM tool, and execution of the planned project in groups of students.	- 10 minutes project presentation; - Theoretical test of objective questions.	40 hours *20 meetings of 2 hours duration.
S5	Planning	Time, and HR.	After the classes about PM tool usage the students have to use a PM tool to apply the CPM, PERT, and resources levelling techniques.	CPM, PERT, and resources levelling techniques.	**Classification:** Experimental Learning **Activities:** Resolution of sequential problems with ascending difficulty levels, involving the application of CPM, PERT, and resources levelling techniques.	Delivery of problems resolution.	4 hours *2 meetings of 2 hours of duration.

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S6	Planning, Execution, Monitoring & Controlling.	Scope, time, HR, cost.	After the classes about PM tool usage the students have to use a PM tool to schedule development, HR allocation, and to analyze monitoring and controlling reports.	Schedule development and HR allocation.	**Classification:** Experimental Learning **Activities:** Elaboration of a project plan using a PM tool, and management of HRs during the simulation of the project execution.	Not informed	1 hour
S7	Planning	Time, HR.	After the classes about PM tool usage the students have to use a PM tool to develop a project schedule using strategies to solve resource constraint problems.	Schedule development, HR allocation and HR levelling.	**Classification:** Experimental Learning **Activities:** Definition of project activities, and its estimations for effort and resources. Execution of different algorithms for schedule development and comparison of their results.	Not informed	Not informed *It was used during a semester.
S8	Planning, Execution, Monitoring & Controlling.	Time, HR, cost.	After the classes about PM tool usage the students have to use a PM tool to schedule development, HR allocation, and to analyze monitoring and controlling reports.	Schedule development, CPM and HR allocation.	**Classification:** Experimental Learning **Activities:** Elaboration of a project plan using a PM tool, and management of HRs during the simulation of the project execution.	Punctuation provided by the educational PM tool, based on project completion and its total cost at ending.	2 hours

Lastly, the data related to the evaluation of instructional strategy effectiveness (RQ3) are presented in Table 11.

Table 11. Data related to instructional strategy evaluation (RQ3).

ID	Evaluation goal	Instrument for data collection	Sample size	Evaluation method	Evaluation level
S1	Evaluate if the students are able to manage and carry out projects systematically with the support of a PM tool.	Observation and PM tool database (to identify the PM tool usage pattern by tickets and wiki records).	Not informed. *Superior to 25	Subjective observation in an ad-hoc manner.	Reaction
S2	Evaluate if the students succeed to accomplish projects according to defined processes and using appropriate PM tools.	- Observation. - Students oral presentation.	130	Subjective observation in an ad-hoc manner.	Reaction
S3	Evaluate the students learning of CPM, PERT, RACI matrix techniques through the usage of an educational PM tool.	Observation and students feedback.	20	Subjective observation in an ad-hoc manner.	Reaction
S4	Evaluate if the students are able to prepare and to present a project plan with the support of a PM tool.	Written test and questioner	47	Evaluation of students grade in the discipline, and questionnaire answers.	Learning
S5	Evaluate among PpcProject and MS-Project PM tools, which one is more appropriate for educational proposes.	Questioner	54	Each student has answered twice a questionnaire. The first time about his experience when carried out a few PM activities using PpcProject, and the other after doing the same with MS-Project.	Reaction
S6	Evaluate if the students are able to manage resources in a project respecting its constraints with support of a PM tool.	Observation and students feedback.	Not informed.	Subjective observation in an ad-hoc manner.	Reaction
S7	Evaluate the students understanding about the CPM and schedule development algorithms through the usage of an educational PM tool.	Observation and students feedback.	121	Subjective observation in an ad-hoc manner.	Reaction
S8	Evaluate if the students are able to manage resources in a project respecting its constraints with support of a PM tool.	Observation and students feedback.	Not informed.	Subjective observation in an ad-hoc manner.	Reaction

VI. DISCUSSION

A discussion based on the extracted data of the SLR is carried out aiming to answer the research questions.

In relation to the PM tools that are taught (RQ1), it had been observed that the MS-Project is the most utilized tool. In part it is because the students familiarity with MS-Office environment and also by its availability on university labs. However, many studies (S1, S3 and S5) points out the lack in this tool for some PM processes, as well, the absence of educational features. In an effort to cover this lack there had been developed educational PM tools, such as DrProject, ProMES, and PpcProject. These tools provide educational features, for instance, the configuration of difficulty levels, profiles for student assistance (step by step explanations) and tutorial videos. In addition, the PM tool PpcProject was compared to MS-Project, demonstrating to be as complete as in relation to the supported functionalities, but superior in educational aspects.

When analyzing the instructional strategies for teaching the usage of PM tools (RQ2), it is observed that in all cases it is classified as experimental learning, because involves the usage of a PM tool during practical classes. Just few studies have reported that some explanation about the PM tool usage is provided before the students start to use it. In other cases, the students need to learn about the PM tool by the exploratory analysis of its functionalities. It also was observed that the time management knowledge area was the most addressed. The HR management was the next most addressed, mainly due to the HR allocation process. It was identified three main kinds of instructional strategies: The first one is related to the execution of practical projects (students organized in groups, build a software and use a PM tool for planning and monitoring it) (S1, S2, S4); The second one focuses on the application of specific techniques, such as CPM and PERT (S3, S5, S7). In this case the instructor presents problems to the students and they work for its resolution using a PM tool. The first strategy covers, at least minimally, all PM process groups, while the second one covers just the planning process group. The last strategy is focused on the management of project resources during the simulation of project execution (S6, S8), requiring the students to make decisions based on the analysis of project monitoring and controlling reports. About

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the discipline hours, the first strategy requires more than others, because it includes the project execution, instead of just the application of specific techniques.

Regarding the evaluation of the effectiveness of these instructional strategies (RQ3), all studies reported at least a subjective evaluation, normally in an ad-hoc manner, based on the authors opinion and in a few cases also the students feedback. The evaluations have concluded that the instructional strategies assist in the learning of PM concepts and prepare the students for the professional career. Some more systematic evaluations were carried out in S4, evaluating its effectiveness based on the students grade, and S5 have applied a questionnaire for students to identify their learning experience. Yet, in most cases the evaluations were classified in the reaction level, with focus on the students' perspective.

It was evidenced that the teaching of PM tools assists the students in the comprehension of PM concepts and provides opportunities to the students to have practical experiences through the application of concepts. However, it was noticed that the instructional strategies are too focused on time and RH management, minimally addressing other PM knowledge areas. None of the studies addressed risk management, quality management, acquisition management and others. In part it may be justified by the lack of support of the PM tools to these knowledge areas. Hence, it is evidenced that the developed IUs for teaching the usage of PM tools does not contain instructional strategies that cover the whole PM process, and the gaps still existing in this area are highlighted.

A. *Threats to Validity*

A common threat in any SLR is the bias inherent to scientific publications that in most cases reports the successes of the experiences, and not its failures. This threat may have hampered the identification of ways to measure the effectiveness of a certain instructional strategy. It was mitigated including a research question to identify how the instructional strategies were evaluated. During the search process the main threat is to not find relevant studies. A migration for this threat includes the use of synonyms for all search keywords. On the other hand, it returned a large amount of results. For instance, the synonyms for the concept of tool bring studies focused on e-learning, games, and simulators. Other mitigating actions included the usage of many data sources, in addition to the manual inclusion of studies based on the state of the art sections of those selected. In the SLR selection phase, the identified threat is related to the influence of the researchers personal opinion. It was mitigated by registering the exclusion criteria that motivated the disposal of each study considered irrelevant, and by the discussion of the results among the SLR participants. This threat also impact on data analysis phase, because some information are not explicit in the studies, and have been inferred by authors.

VII. CONCLUSIONS

This work aims to identify which instructional strategies are been adopted in the teaching of PM tools usage in superior computer courses. To reach this goal, it was carried out a SLR, identifying the most relevant studies in the area. The results show that, typically, the teaching of PM tools usage is carried out in practical classes and the instructional strategies varies from specific problems resolution or planning a software project. The educational goals in general are focused on the teaching of time and HR management, minimally or not addressing other PM knowledge areas. In part it may be justified by the lack of support of the PM tools to these knowledge areas. Hence, despite the efforts, it is evidenced that the teaching of PM tools usage still does not cover the whole PM process, which is essential for a more efficient PM. Future work may suggest other instructional strategies to fill these gaps, through the adoption of a systematic PM process that covers all knowledge areas, and the usage of a PM tool aligned to such a process.

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