DELIVER! – An educational game for teaching Earned Value Management in computing courses

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A B S T R A C T

Context: To meet the growing need for education in Software Project Management, educational games have been introduced as a beneficial instructional strategy. However, there are no low-cost board games openly available to teach Earned Value Management (EVM) in computing programs.
Objective: This paper presents an educational board game to reinforce and teach the application of EVM concepts in the context of undergraduate computing programs complementing expository lessons on EVM basics.
Method: The game has been developed based on project management fundamentals and teaching experience in this area. So far, it has been applied in two project management courses in undergraduate computing programs at the Federal University of Santa Catarina. We evaluated motivation, user experience and the game's contribution to learning through case studies on Kirkpatrick's level one based on the perception of the students.
Results: First results of the evaluation of the game indicate a perceived potential of the game to contribute to the learning of EVM concepts and their application. The results also point out a very positive effect of the game on social interaction, engagement, immersion, attention and relevance to the course objectives.
Conclusion: We conclude that the game DELIVER! can contribute to the learning of the EVM on the cognitive levels of remembering, understanding and application. The illustration of the application of EVM through the game can motivate its usefulness. The game has proven to be an engaging instructional strategy, keeping students on the task and attentive. In this respect, the game offers a possibility to complement traditional instructional strategies for teaching EVM. In order to further generalize and to strengthen the validity of the results, it is important to obtain further evaluations.

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1. Introduction

Project management (PM) is the discipline of planning, executing, monitoring and controlling resources to successfully complete a project. It is a key factor for delivering successful projects on time and within budget. In recent years, all business sectors, including the software sector, have increasingly recognized PM as a core competence [1,2]. As a consequence, the need for project managers has never been greater than today [3]. Many organizations are looking for trained project managers, who can fill the gap between executive managers and the "techies". As this occurs, the need for PM education and training in the software sector grows. Project managers have long been trained on the job with little formal training on PM [4–6]. Many project managers take on their job reluctantly and unprepared [7]. Especially, in computing courses, PM is still considered a minor topic [8], taught as only one of several topics in software engineering classes. To compensate for this lack of formal PM education, a vast variety of professional training courses are offered and certifications, such as, PMP – Project Management Professional (http://www.pmi.org) are demanded for PM professionals.

Another issue is the way in which PM is typically taught. Expository lessons are still the dominant instructional technique [9]. They are adequate to present abstract concepts and factual information. But, they are not the most suitable for higher-cognitive objectives aiming at the application and transfer of knowledge to real-life situations [10]. On the other hand, practical constraints regarding class duration and instructors' effort usually limit the

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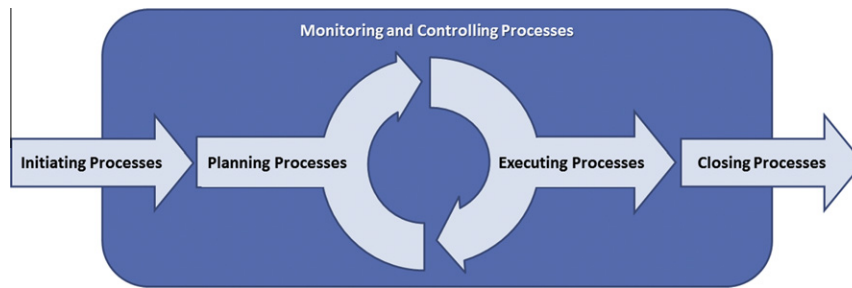
Fig. 1. Basic project management phases [2].

possibilities of students to exercise the concepts and techniques [11]. Therefore, it remains a challenge to teach students in a compact, but effective and motivating way.

In this context, serious games have become an alternative offering various advantages [9]. They can help to reinforce basic concepts. Games can also contribute to teach higher-cognitive competencies illustrating their application and relevance with acceptable training time and instructor load [12]. And, building on the engaging nature of games, they can make learning more fun, if not easier [13].

In this context, we developed an educational board game DELIVER! to support the learning of Earned Value Management as an important part of teaching PM in computing courses.

2. Background: Earned Value Management

Project management is the application of knowledge, skills, tools and techniques to project activities to meet the project requirements. Basic phases of the PM life cycle include: project initiation, planning, execution, monitoring and control and closing (Fig. 1) [2].

In relation to the focus of this paper, monitoring and controlling processes are required to track, review and regulate the progress and performance of the project (monitoring) and to identify areas in which changes are required and to initiate the corresponding changes (controlling) [2]. Their key benefit is that project performance is observed and measured regularly to identify variances from the project plan. It includes monitoring and control of work progress, schedule and costs, in order to measure, compare and analyze schedule performance (e.g., comparing actual start and finish dates with planned ones) as well as budget performance variations in the actual spending.

One of the most prominent techniques to monitor and control projects is Earned Value Management (EVM) [14]. It can play a crucial role in answering management questions, such as, if the project is behind schedule, over budget, what the remaining work is likely to cost, etc.

EVM allows the indication of performance variances and indices based on the planned values in the project plan baseline and actual work performed and cost (Fig. 2).

EVM includes the following key dimensions:
- PV – Planned Value is the authorized budget assigned to the work to be accomplished for an activity or work breakdown structure component.
- AC – Actual Cost is the total cost actually incurred and recorded in accomplishing work performed for an activity or work breakdown structure component.
- EV – Earned Value is the value of work performed expressed in terms of the approved budget assigned to that work for an activity or work breakdown structure component.

Using these key factors, variances and/or performance indicators with respect to time and cost can be calculated:
- Schedule Variance (SV) is a measure of schedule performance calculated by: $SV = EV - PV$.
- Cost Variance (CV) is a measure of cost performance calculated by: $CV = EV - AC$.
- Schedule Performance Index (SPI) is a measure of progress achieved compared to progress planned on a project. $SPI = EV/PV$
- Cost Performance Index (CPI) is a measure of the value of work completed compared to the actual cost or progress made on the project. $CPI = EV/AC$

EVM can also be used for forecasting:
- EAC – Estimate At Completion forecast for work performed at the budgeted rate. This method accepts the actual project performance to date as represented by the actual costs, and predicts that all future work will be accomplished at the budgeted rate. $EAC = AC + BAC - EV$ with BAC – Budget At Completion.
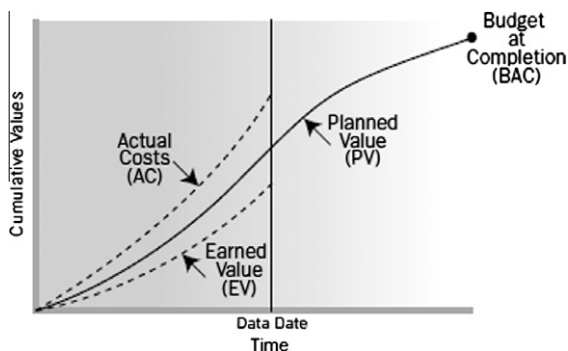

These measures support project monitoring as shown, for example, in Fig. 3.

Providing these measures by integrating work progress, schedule and cost information, EVM is a valuable tool for project monitoring and control.

2.1. Teaching EVM in computing courses

A course on PM is considered a part of any kind of undergraduate computing program [8]. Learning objectives of such a course, among others, include enabling the students to monitor and control projects, presenting EVM as a performance monitoring method. On the undergraduate level, it is expected that students acquire EVM knowledge on the cognitive levels of remembering,

Fig. 2. Overview on EVM key dimensions [14].