

Exploring the Possibilities of Using Project Management Methodologies in the 21st Century Education

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Abstract. One of the reasons why education in the 21st century is different, is the use of technology to enhance learning. In this context, proper project management methodology that individualize learning and makes students take responsibility for their own learning, reflect and evaluate their own learning processes, must be implemented. The educational process is approached as a result of the project management methodology considering previous experiences regarding education projects and exploring the possibilities of adapting to the dynamics of the digital age. A successful education process delivers effective learning being designed in order to enhance it. In the context of the research, Web 2.0 tools proved to be useful educational tools with significant results especially when integrating elements of Google Analytics and Gamification. So, the article proposes a framework for integrating a mixture of Web 2.0, Google Analytics and Gamification in the educational process.

1 Introduction

The approach of educational processes considering Project Management (PM) methodologies is based on the fact that educational process must be planned, implemented effectively, and managed professionally in order to reach the established objectives in terms of functional performance, time and efficacy.

PM has evolved in order to effectively manage human capital and other resources for delivering specified requirements, time scale, budget, quality standards for a product or a service [1]. The application of PM methodologies to areas of the educational process like curriculum development was questioned along time, and several problems, including cultural aspects of the educational environment and the independent nature of the academic work were pointed out.

As stated by [2], introducing PM approach to educational projects is an advantage, the efficient use of scarce resources, and noted some inadequacies between the classical approach of PM and the nature of educational work. [1] presented PM as "the application of

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knowledge, skills, tools, and techniques to a wide range of activities so as to meet the requirements of a specific project" [3].

The United Nations Development Program [4] defined the education project as the smallest operational unit, which is prepared and implemented as a separate entity within the educational program. Nevertheless, the education project plans have two functions: to mobilize efforts for educational development and to provide a coherent framework that is needed for the integration of these efforts.

[5] suggested five ways to apply PM methodologies in education, stressing out the importance to acquire the ability to manage projects. Yet management of class in the 21st century is different due to new challenges arose.

The importance of meeting these challenges and the most important aspects to be addressed are presented below according to [6]:

- Digital responsibility. The students are helped to have a healthy relationship with technology, to be safe and confident in exploring the digital world, and skilled prepared for life workforce.
- Life skills. Social and vocational skills like emotional intelligence make students understand themselves, their connections to others and to the world in order to act properly.
- Computational thinking. Students are able to develop problem solving skills alongside with digital skills in order to be prepared for future jobs.
- Student led learning. Students take responsibility for their own learning, also known as autonomous learning which is enhanced by introducing technology, or as student-centered learning.
- Collaborative classroom. The focus is on openness, flexibility, and collaboration between students, known also as networked learning where more collaboration between students will mean more effective learning that includes the acquirement of 21st century skills. This requires redesigning the class structure where no longer all students are facing the instructor and the blackboard.

Given the significant changes and the critical aspects regarding the application of classic PM methodologies in education, Agile methodologies were considered. These are presented and analyzed in *Section 2 - Landmarks of the relationship Agile Development – Educational Process*, providing a comparative perspective for a better understanding of the adequacy of these methodologies to the changes that determine the challenges of the current digital age.

Section 3 – Agile in Education, presents in addition to pro arguments for using Agile methodologies in education, the description and justification based on previous studies of two of the Agile methodologies: Extreme Programming and Scrum.

In *Section 4 a Framework for integrating a mixture of Web 2.0, Gamification and Google Analytics in the educational process* is discussed.

2 Landmarks of the relationship Agile Development – Educational Process

Initially, Agile methodologies were used in projects related to software development, facilitating teamwork in a collaborative research process over waterfall model [7]. Agile teams operate in cycles, using frequent iterations over time, which allow for periodic recordings and feedback, along with their final product customers [8].

In 2001, a team of 17 software leaders published the “Manifesto for Agile Software Development” where they define the values and principles of Agile software development as a summary of what they authored “better ways of developing software by doing the software and helping others do it better” [9].

The main idea was to insert an incremental and iterative method instead of an in-depth planning in the beginning of a software project. Agile methodologies in general are open to many changes in requirements and encourage constant feedback from end users and customers alike. Agile way of handling projects had produced several methodologies, all following its philosophy [10] presented in figure 1.

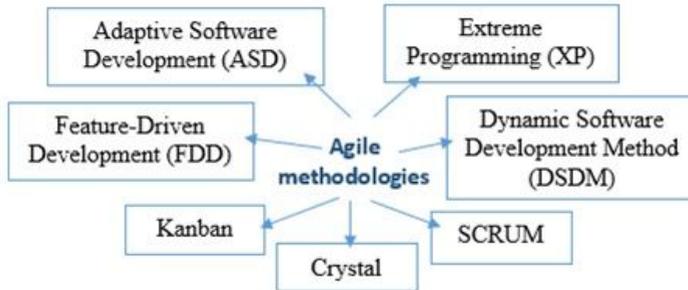


Fig. 1. The Agile methodologies.

Many researchers had tried to tailor Agile methodologies to the educational environment. [11] presented a cross relation of the Agile methodologies in education showing how they can be applied to educational projects. They provided a mapping between many of the values and principles of the Agile Manifesto and how can be fulfilled to specific educational methods and themes. The mapping is summarized in Table 1 which compares Agile in general and Agile in Education.

| | |
|--|---|
| <i>Individuals along with interactions are more important than processes and tools</i> | When applied to the context of learning, means that the teacher will focus on working with students on one-to-one basis and will be flexible in adjusting the process and any tool used |
| <i>Working software over comprehensive documentation</i> | This suggests shifting the emphasis from writing a report to building products which can be used in a professional environment. |
| <i>Customer collaboration is more important than contract negotiation</i> | When applying this to learning, the teacher needs to collaborate with students instead of enforcing assignments and associated rules and orders |
| <i>The need to respond to change over the need to follow a plan</i> | The need for the teacher to be willing and available to shift from the traditional course schedule and to adjust his/her schedule in order to respond to students' needs as they arise. |

Fig. 2. The application of Agile principles in education.

So, according to the Agile Manifesto in Education [12,13] follows that: Teachers and Students are more important than Administration and Infrastructure, Attitude and Learning skills over Aptitude and Formal degree, Competence and Collaboration over Compliance and Competition, Employability and Marketability over Syllabus and Marks. The application of Agile principles in education according to [14] is presented in figure 2.

Table 1. Comparison between Agile in General and Agile in Education.

| | Agile in General | Agile in Education |
|------|--|--|
| (1) | When it comes to high priority for customer satisfaction, in order to early and continuously delivering valuable software. | High priority for preparing student to be self-organized, and at the same time delivering continuously course components which reflects competence. |
| (2) | Requirements that can change at any time for the advantage of customer's competitiveness. | The instructor and students' willingness to adapt to changes continuously in order to facilitate learning and to better develop marketable skills. |
| (3) | Delivering working software frequently with a preference to a shorter timescale. | Obtaining working deliverables from the student over short time periods to allow for frequent feedback. |
| (4) | Business people and developers need to work together daily. | Iterative interaction between the instructor and the student or students in groups (teams). |
| (5) | Building projects around motivated individuals and the need to support them in a proper environment. | Giving students the environment and the support, they need in order to succeed in their learning experience. |
| (6) | Face-to-face conversation between customer and developers. | Allowing direct face-to-face interaction with students or student groups. |
| (7) | Working software as the primary measure of progress. | Students work, like software, models, presentations and project deliverables, as the primary measure of student progress. |
| (8) | The users, sponsors, and developers need to maintain a constant pace all the time. | Cooperative learning environment as the basis for teaching the skills needed for life-long learning. |
| (9) | The need for continuous attention to technical excellence and good design enhances agility. | Learning enhancement occurs when focusing on the need for continuous attention to technical excellence and good design. |
| (10) | The call for simplicity as an essential component. | Understanding the problem and solving it simply and clearly as an essential component. |
| (11) | The element that addresses the best requirements, architectures, and best designs which emerge from teams that are self-organized. | Student groups and student teams should self-organize, and they all should participate equally in the effort to succeed. |
| (12) | In regular intervals, the team reflects, then discusses how to become more effective, then adjusts its behavior accordingly. | Students and instructor's reflection and their feedback show them how to be more effective, then all the participants will adjust accordingly in order to be more efficient. |

3 Agile in Education

By adopting Agile methodologies, there will be more engagement of the participants, along with reflection and adaptive actions, and also, a greater sense of ownership and a better experience [8].

As learning becomes more personalized, it requires to adjust to ever-growing changing conditions and requirements, so there is a need to continually search for new methods that can meet the new challenges for achieving Education for Sustainable Development (ESD) [15]. For that reason, new practices within formal learning environments have to be examined to search for innovative practices that support learning in a collaborative way [16-18]. Hence, Agile methodologies were introduced mainly as an alternative to traditional project management methodologies that are based on thorough and sequential planning in

the waterfall models. Since education is mainly based on planning and implementing multiple projects that consist of a series of specifications, as programs, courses, sessions and assignments are all projects with different magnitude in which both teachers and students participate together. Additionally, Agile praises adaptive development by introducing short continuous cycles of planning phase, action phase, correction phase and adjustment phase in order to produce valuable increments in outcomes. In general, the project is first defined before executing it, which includes all the specifications, human resources, financial resources, tasks and timing need to be defined before starting the actual work. In implementing Agile in education, the focus is on using incremental or iterative approach instead of deep planning in any educational project, as Agile methodologies are flexible and open to new changes and new requirements in order to encourage constant feedback from teachers and students alike.

The use of Agile in K-12 education specifically is documented in many scientific papers [19-21]. [19] for instance described the design and practical implementation of an educational project framework which uses animations and programming with Scratch in order to teach computational thinking skills based on Agile practices. [22,23] mentioned the effectiveness of applying Agile methodologies in online courses. [24] reported a study which applies Agile methodology in two project-based learning courses in a specialized subject like Electrical Engineering. [25,26] presented the use of Kanban board in project-based learning. Kanban boards are electronic tools that are used for the management of work in groups in order to improve quality level for delivering the product or service. This includes many aspects like product or service quality, predicting life cycle, and required time frame.

Two methodologies will be presented next: Extreme Programming (XP) and Scrum. A description and justification will follow based on previous studies.

3.1 XP in Education

An instructional design methodology which exploits XP along with project-based learning was proposed by [27]. There was revealed the usability of the XP methodologies for teaching based on the framework of the continuous change in the educational environment. Similar to Agile Manifesto in Education, [27] adapted the similar values of Agile to the educational environment in order to apply the XP methodology which includes the following:

- (1) The collaboration between students and teachers over processes and tools.
- (2) The collaboration between students, teachers and parents over educational agreements.
- (3) Exciting activities over instructional design documentation.
- (4) The design, problem solving and task performing over concepts and knowledge.
- (5) Respond to feedback is more important than following plans. This means that the highest priority for the project leader is to satisfy students and their parents through continuous production of projects validated by team members, and consequently, to achieve the results.

So, during each iteration of the project teachers and students will closely cooperate. More important is that the educational projects have to be designed in a way to solve complex real-life problems but well suited in order to generate the level of expected knowledge, skills, and capabilities. Therefore, the project must include critical activities, analysis, problem-solving, and synthesis in order to be applied individually or/and collaboratively between the team members. Yet project proposals need to be presented in the form of stories and to be shared with students and teachers because they represent the important stakeholders.

[28] reported the use of XP in education as a methodology applied in Software Engineering courses and presented the experiences and the best practices deduced from applying XP in three different labs, in an experiment conducted during a Software Engineering three years course. It was found out that when organizing the labs to practically experience most of the XP practices, and a valuable experience in improving the programming and social skills of students was achieved. [29] conducted a similar study over five different academic levels of XP practices that had shown that all students accepted and liked XP.

3.2 SCRUM in Education

There are many scientific papers that harnessed the power of Scrum in order to use it in education as shown in the work of [30] in eduScrum. The guide translates the teacher role to a Product Owner (PO) who is responsible to decide what materials need to be learned, to monitor, process, and evaluate students. The main goal is to deliver the highest value which is translated into both discipline specific learning outcome and soft skills that includes organization, collaboration, planning, and teamwork. The student team is considered to be self-organized; its aim is acquiring learning results in an iterative and incremental way. Then, the eduScrum Master (SM), who is chosen by the teacher will act as a coaching leader and will help the team to perform up to its highest level of performance. The sprints are also mapped into the education context. The planned tasks are considered as time boxed events with a specific duration and designed to allow for inspection and critical transparency. Thus, the sprint is merely a collection of tasks which is organized coherently in order to achieve the learning goals. The ceremonies expected in eduScrum consisted of a planned meeting at the beginning of the sprint in order to define the team formation, its learning goals, and the planned work which needs to be done. There is a stand-up at the beginning of every class that last about five minutes in order to synchronize activities and to make plans for the next meeting. There is also a review of past activities of the last sprint in order for the members of the team to display what they have learned so far. There is also a review in order to create a plan for improvement and to prepare events for the next sprint. As for the Scrum process that was used to teach Software Engineering, the scientific literature reports many practices that were successfully employed [31].

[32] studied the use of Scrum in K12 setting and presented a case study of software development teaching using Scrum. The experiment run in seven classes from different schools, the same software project being assigned in all of them. There were created two teams in every class each with different methodology, one for classic waterfall and one for Scrum. Even when considering the young age and shallow experience of participants, the authors suggested strikingly that Scrum was more effective in education than the traditional Waterfall methodology. Yet there was a compromise between the two methodologies, namely planning and structure from Waterfall method and creativity and reactivity from Scrum method. Another successful use of Scrum in Higher Education was in the areas of games (LEGO) as mentioned by [33, 34]. Another example used in games is SCRUMIA, but it involves different setup, after forming student's teams then they are asked to develop different artifacts, using only paper and a pencil, over multiple sprints. Additionally, Scrum was employed effectively as an educational and management method in interdisciplinary educational settings [35]. Groups of programmers, artists, and user interface designers were managed in order to produce six different educational game projects. According to [36], Scrum was also used to teach other subjects. [37] presented Scrum methodology implementation in classroom management procedures in Higher Education and specifically in a Discrete Mathematics course. The aim was to get students to take more responsibility for their learning, to make them enjoy the self-management and the crafting of their

learning process. The teams of students had the option to choose from lecture-based learning, traditional or interactive online textbook reading, and online video-learning. Each team kept a project management progress board in order for the PO, i.e. the lecturer, to track team progress toward self-selected indicators. Teams worked independently to achieve their goals, some periods were dedicated for lecturing, but students felt that these were more like group discussions. [38] investigated the use of Scrum methodology in a Mechatronics university level course. The materials used were defined as an integration of electronics, software engineering, mechanical engineering, and control engineering. The results showed that Scrum methodology enabled the students to reach better results.

4 Framework for integrating a mixture of Web 2.0, Gamification and Google Analytics in the Agile educational process

The emerged Web 2.0 applications have the potential to enhance learning opportunities being a support for lifelong competence development. Using Web 2.0 technologies, can help increase student learning using student's preferred learning style, increase motivation, align to personal interest, and raise engagement.

[39] pointed out that student motivation will be high if the technology applied will be used in a creative way, like video editing, iPod self-pacing, and Web 2.0-project collaboration. Therefore, it is not enough to simply place work on a laptop, teachers must think of different ways to shift their deep-rooted preferences for worksheets, lecture, and assessment to include in their plan's alternative approaches to learning through meaningful creation in project driven curriculum. In this context, the solution proposed is the use of the Agile methodologies as a PM approach, integrating Google Analytics and Gamification.

Google Analytics (GA) is an example of the power of Learning Analytics (LA) in order to produce statistical data that is related to learning. GA provides time series data [40]. The use of GA as a Web 2.0 application will enable the teacher to see and to analyze data (number/duration of visits per hour/day/month, demographics, countries, referrals and resources).

Gamification is the application of game elements and digital game design techniques to non-game problems, such as business and social impact challenges [41]. Students' engagement in a gamified learning activity can result in a better learning outcome [42]. Many studies on Gamification argued that by motivating students through a reward-based learning method, their learning skills will be enhanced and eventually their learning outcomes will be increased [43, 44].

So, as the use of LA dashboards support awareness, self-reflection, sense making and impact for learners [45], the implementation of game elements like badges in non-game environments has become increasingly popular [46]. Several Gamification techniques have been used in different settings in order to stimulate students' learning outcomes and enhance learning [47-49] providing a remedy for many students who do not resonate with traditional methods. Using Gamification can provide a partial solution to the declining motivation and commitment of students facing the school system today [50]. The benefits can reach teachers too, in an increase in their motivation [51], even though there are skeptics on its effect on improving academic performance [52-54].

The benefits of using Web 2.0, GA and Gamification can be materialized through the Agile methodology. So, we propose a framework for integrating these elements.

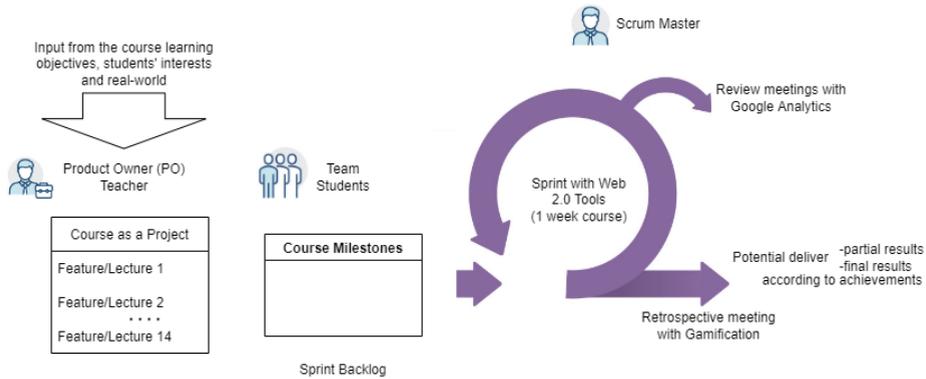


Fig.3. Framework for integrating a mixture of Web 2.0, Gamification and Google Analytics in the Agile educational process.

In figure 3 there is presented the framework for the educational process approached using Agile-SCRUM methodology. The teacher, that is the Product Owner, prepares the main features for a course treated as a project addressed through Agile, taking into consideration as inputs the learning objectives and typology of the students, all of these related to the present real-world conditions. The extracted features are discussed with the Team, that is formed up of all the students, and are determined the course milestones in terms of time, targeted level of accomplishment of the tasks, that are assignments, laboratory works. Each sprint has several tasks allocated. The Web 2.0 tools are used in each course/sprint, that usually spans on one week. Google Analytics tools are used to quantify the achievements in each sprint. Gamification tools are integrated for assessing the results from each sprint and prepare for the next one, in terms of motivation. The output, or the potential deliver, represents an image of the achievements either as partial or final results, translated into marks, GPA or other grade scale and personalized badges.

5 Conclusions

ICT is widely considered to have the ability to lead to significant educational outcomes along with support to students' development to acquiring the knowledge and skills that they need to succeed in the 21st century society and after the Covid-19 Pandemic. So, using Web 2.0 technologies which include blogs, wikis, social bookmarking, social networking, RSS, media sharing, podcasting, etc., enabled students to acquire many parts of the digital literacy requirements, hence, academics, researchers, educators and policymakers have encouraged the use of these emerged Web 2.0 applications and acknowledged the potential to offer for enhanced learning opportunities. Based on the Web 2.0 application and implementation in the educational process, there are certain approaches meant to help improve education through the emerged Agile approaches. The contribution of the article is related to the applicability of Agile methodologies as well as of including Google Analytics techniques and Gamification tools which can further improve the educational process.

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