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E-EXPERIMENTS IN PHYSICS PROPER BUSINESS PROCESS MANAGEMENT, COLLABORATIVE DEVELOPMENT PROCESS AND PROJECT MANAGEMENT GUIDANCE – REMEDY FOR AVOIDING THE MAIN IT PROJECT'S FAILURE

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Abstract: Only a few of learning aids and simulations of physical phenomena allow for building interactive experiments; experiments similar to those that should be conducted in physics laboratories at schools. Group of staff from Gdansk University of Technology decided to fill this market niche by designing and constructing a set of virtual experiments – so called e-experiments. To avoid common problems that a lot of IT products brought to failure, they prepared procedures in accordance with the best practices of software and requirement engineering. If requirement specification and development process have been preceded by proper and detailed stakeholders' identification and characteristic, there is a chance that product will be widely accepted. The paper below describes the process of the e-experiments development with the consideration interests of the target group – young people from e-generation (digital generation) and the teachers.

Keywords: good practices; software engineering, requirement engineering; stakeholders; risk analysis, risk management

1. INTRODUCTION

Many surveys have been conducted to find out how many IT projects end in defeat and to determine the factors which result in their failure. The most commonly indicated reasons for IT project failure are ineffective stakeholder engagement, [1] a complete lack of executive support, ineffective user involvement [1; 2; 3; 4; 5; 6; 7; 8; 9] and poor project management (lack of knowledge of project management methodologies and the competence of management - inadequately trained and/or inexperienced project managers; lack of top management involvement and support; inadequate risk management and a weak project plan). Another important reason is a lack of domain knowledge among project team members.

A lack of client/end-user commitment usually leads to 'challenges' surrounding requirements that may increase the risk of not fulfilling clients' needs. This means that the software does not satisfy the quality conditions specified in the ISO 9001:2000/2008 definition of software quality [10]. Having experience and knowledge deficiencies in the subject area of the project may lead to gaps (undefined requirements arising from lack of awareness of the domain of the problem) in software requirement specification or work on unattainable objectives in subsequent project phases. Of course the software developer is not expected to know everything. However, it is necessary to fill in the gaps. For this purpose it may be helpful to use other sources of information such as documents, standards and the knowledge of domain experts. On the other hand, poor or inadequate project management contributes to improper organization of the project team's work. Then, even if project goals (requirements, tasks etc) are defined properly, the achievement of an objective may be hampered or impossible.

All of these considerations have influenced the project designers who are working on the e-Experiments in physics project to make all reasonable endeavours to prepare a product that fully satisfies future users. Set of activities were planned to achieve this goal. This paper describes the software engineering process which they view as resulting in success.

2. E-EXPERIMENTS IN PHYSICS

"e-Experiments in physics" ("e-Doswiadczenia w fizyce") is an innovative educational project, carried out in Poland by the Faculty of Applied Physics and Mathematics (FAPM) at Gdansk University of Technology (GUT), in cooperation with Young Digital Planet SA, Gdansk, Poland (YDP) and L.C.G. Malmberg B.V., Den Bosch, the Netherlands (LCG) as a foreign partner. Each partner has some experience in carrying out similar projects. For example: "Za rękę z Einsteinem" ("By the hand with Einstein"), a program promoting equal educational opportunities for pupils from villages (at FAPM);

multimedia, educational programs and educational content based on ICT for individual recipients, educational institutions and businesses (YDP); publications of educational solutions assisting students in learning through multimedia systems and modern ICT (LCG).

The main purpose of the project is to fill the gap in the educational software market, by designing and constructing a set of virtual physics experiments, referred to so-called e-experiments. An application, according to assumptions made by the originator of the project, should allow for building interactive experiments; experiments similar to those that should be conducted in physics laboratories at schools. From the very beginning a famous maxim of Confucius: “Tell me and I will forget – Show me, and I will remember – Let me do it, I will understand” has been followed. Additionally, the team project members have always repeated: “Our task is not to replace reality; we just want to enrich the existing curriculum by the experiments, which – for various reasons – rarely take place during physics lessons. We want to help students learn by practice in accordance with the model of: <<design, build, perform, analyse, present results>>, because we believe that this is the only way they can fully understand the laws that govern the world around us”.

The project is carried out as an answer for the call for proposals under the subject “Development and implementation of innovative pilot programs, such as training in mathematics, science and technology and entrepreneurship". It runs during the years 2010-2014 and has been carried out in two stages. The first stage, preparatory, consisted of analysis, thorough diagnosis of the problem, establishing a preliminary version of the project and preparation of the deployment strategy. In the second stage, during the pilot deployment in 20 upper secondary schools, the product was tested, then feedback from schools was analysed in order to confirm the outcome, and the final version of the product was developed. This final product was already validated by the National Supporting Network, so the quality and usefulness of it has been proved. The end of the project should be accompanied with dissemination of its results. After that, the Polish Ministry of National Education (as the institution announcing and supervising the performance of the project) will decide whether the project can be included in mainstream educational policy or not. In order to obtain a positive opinion and decision, the project team has initiated a number of activities that should be carried out to improve the quality of the final product. Some of them, such as monitoring and evaluation, were imposed by the promoter. The other steps were left to the decision of the originator of the project.

2.1. Close cooperation with domain experts

As the most important is to well know domain of the project a project team composed of subject matter experts and a developer’s team was created. The experts, mainly members of staff and students of the FAPM at GUT, carried out their duties with due care and using their best knowledge and experience gained during their academic work. At the head of the group was a coordinator who builds a team of qualified personnel and supervises the team’s work. Its main task consists of preparing the scenarios (kind of software requirement specification) and prototypes of the e-experiments (in the form of C++ codes). Subsequently the documents drawn up were sent to YDP. The scenarios were written and provided with comments by their team leaders (at least one of them acquired (domain) knowledge of a project subject – in physics). These two steps were repeated until any ambiguities were eradicated. The developer’s project team started implementing the scenario (in the Adobe Air technology). All of these activities were repeated for each of the 23 e-experiments planned to be carried out.

2.2. Involving and executive support stakeholders’ into project

Firstly, the recipients (teachers) and users (students) of the product were asked about their opinion during research on behalf of the GUT [11]. Their opinion was one of the first steps to collect information about stakeholders’ needs. Subsequently, the ready-made e-experiment was tested by a team of experts. The bugs found by them were reported to members of the YDP project team and corrected. Thereafter, the teachers of the upper secondary schools taking part in the project were asked to test and make comments on the product. When all indispensable and well-suited corrections were introduced the e-experiment is delivered to schools for students. Finally, before the product was proposed to be included in mainstream educational policy the students’ comments were gathered and acted upon (if applicable). All of these activities were repeated for each of the 23 e-experiments planned to be accomplished.

All the necessary training for the users of the product was conducted.

Every e-experiment is placed on the project web page on a regular basis and access is granted to anyone who may be interested.

2.3. Digital users

To better assess the integration of e-Experiment into the classroom experience, the current section aimed to understand characteristics, benefits, barriers, and other factors affecting the end users’ acceptance of IT product. In classrooms the impact of technology depends on both the teachers and students who use it.

It is well-known that current students are more knowledgeable than their teachers in ICT. To describe students who were born into and raised in the digital world Prensky [12] coined the terms “digital natives”, in opposite teachers have been described as “digital immigrants”. The nature of technology usage between digital natives and digital immigrants are presumably different [13].

Other researchers called students the “net generation” [14], the Google generation, the millennials or “new millennium learners” [15]. All of these labels are being used to emphasize the significant role of new technologies in many areas of their life activities: communication, recreation, socialization and education [e.g. 12; 16]. Digital natives have been raised in technology-rich environment, which has shaped how they think, behave and learn [13]. Academic commentators highlighted that they are fluent in the language and culture of computers, video games and Internet, adopting to changes in technology and using ICT in unconventional way. Consequently, students revealed specific learning style as a result of being immersed in ICT for their entire lives. For instance, Pedró [15] observed that “new millennium learners are used to gaining knowledge by processing discontinued, parallel information, giving priority to pictures, movement, and music over text, feeling at ease with multi-tasking processes and accessing information mainly on digital sources” (p. 10).

In classroom current students prefer involving experiments and games as a form of effective teaching methods. They have strong needs of creative experience and control during learning process [13]. It is a teaching challenge for digital immigrants who have had to adapt to the new educational environment. Bingimlas [17] found that teachers had a strong desire for integrating ICT into education, they encountered many barriers (like lack of confidence and competence, or having negative attitudes and inherent resistance), which are essential to the success of ICT integration.

2.4. Project management

As the project is co-financed by the European Union within the framework of the European Social Fund, the supervising institutions expect the preparation of a few formal documents. These papers together with records created by the team on its own initiative force the provision of, paying proper attention to detail, good planning and appropriate risk analysis. If any problems with the execution of the project are found, relevant procedures are implemented. For example: when a delay in the completion of a task arises, the primary schedule may be updated, or the work of the team may be reorganised without the risk of postponing the final deadline. These actions have been already implemented when as a result of working on other activities YDP's company could not commit enough staff to the project. The pace of performance tasks was slackened. The lost time will be made up by developing less time-consuming experiments. The human resources management also undergoes changes. When an employee cannot manage to do their assigned job for a long period of time, the reorganisation of the team is considered. A further example is that when a change in the initial assumptions proved necessary, there were problems with coding the equations describing the motion that preserves realism. This task was delegated to the subject matter experts who had appropriate knowledge and experience in using programming languages.

The final product has already been demonstrated at conferences, seminars and programme meetings of the Human Capital Programme and National Supporting Institution. It has been extremely well-received everywhere.

3. PLANS FOR THE FUTURE

The presence of a few different sources of requirements may cause some of them to overlap. To resolve this problem it is necessary to confront and/or prioritise sources. This also applied in the case of gaps in requirement specification. Even when several sources of information are present, this does not provide a guarantee for filling in all the gaps. For this purpose it may be necessary to use a more sophisticated tool. But this is the subject of another survey and will be described in some further work.

4. CONCLUSIONS

Following procedures described in the above paper as the best practices is a matter of great importance if developers of any IT system want to achieve success. In particular, the project "e-Experiments in physics" was a success, which confirms the thesis posed in the publication. The overall objective of the project was to increase the efficiency of the interest of secondary school students in science. The information presented in the reports of the internal and external evaluation of the project [18, 19] shows as indisputable fulfilment of this goal through the implementation of specific objectives. Benefits of the product were emphasised in interviews by both teachers and students. It was also noted that the use of the product in the classroom forces more dynamic and more attractive teaching physics. Lessons through the use of the product are less boring, and students indicate that it is easier to remember the knowledge taught using e-experiments.

The lesson learnt from the project was put into next project also regarding kind of e-education but regarding cross-sectored and cross-aged/cross-generational group of users and recipients prepared by the two of article authors. As the one of the authors (MAP) research interest are stakeholders, requirements and looking for an answer how to tailor software to stakeholders' needs the following case study was described in her Ph.D. thesis that is under preparation.

It should be emphasised that efficiency work different people can determinate the project victory. The transfer of knowledge between two or more fields of science may be also one of the success factors. The computer scientists need the physicist to faithfully represent the reality. They may find helpful to ask the psychologists and/or the sociologist how to meet their stakeholders needs and/or prepare product (not just IT one) that can be proved to be bestseller (they do teach e.g. Consumer Psychology at Institute of Psychology). To summarise, under e-experiments in physics project were working together group of the physicists, teachers, computer scientist and students (end users of the product). In the second mentioned project addressed to wider community and society is planned to involve into work also psychologist and non-government organisation that better understand society needs. We are looking for the next success.

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E-DOŚWIADCZENIA W FIZYCE. WŁAŚCIWE ZARZĄDZANIE PROCESAMI BIZNESOWYMI, KOOPERATYWNY PROCES TWORZENIA ORAZ WZORCE ZARZĄDZANIE PROJEKTAMI - REMEDIUM NA UNIKNIĘCIE NAJWAŻNIEJSZYCH PRZYCZYN PORAŻEK PROJEKTÓW INFORMATYCZNYCH

Na rynku można znaleźć wiele pomocy naukowych i symulacji zjawisk fizycznych – występują one jako samodzielne aplikacje lub jako składnik większych pakietów edukacyjnych. Jednak tylko niektóre z nich umożliwiają budowanie interaktywnych eksperymentów podobnych do tych, które powinny być przeprowadzane w laboratoriach fizycznych w szkołach. Grupa pracowników z Politechniki Gdańskiej postanowiła wypełnić tę niszę na rynku poprzez zaprojektowanie i budowę zestawu wirtualnych eksperymentów - tak zwanych e-doświadczeń. Wytworzenie produktu informatycznego zgodnie z wcześniej opracowanymi procedurami i dobrymi praktykami inżynierii wymagań pozwala na uniknięcie typowych problemów, a następnie na jego wdrożenie. Dopiero wtedy deweloper może się przekonać czy jego rozwiązanie zostało dobrze przyjęte przez jego przyszłych użytkowników. Jeśli proces tworzenia specyfikacji wymagań i implementacja zostały poprzedzone prawidłową i szczegółową identyfikacją oraz charakterystyką udziałowców to jest szansa, że produkt zostanie zaakceptowany. W wystąpieniu opisany zostanie proces tworzenia e-doświadczeń, ze zwróceniem szczególnej uwagi na grupę docelową - młodych ludzi należących do tzw. e-generacji (cyfrowego pokolenia) i nauczycieli, odpowiedzialnych za ich edukację w dziedzinie fizyki.

Słowa kluczowe: współpraca, eksperci merytoryczni, e-doświadczenia w fizyce, e-generacja, pokolenie cyfrowe, wykonawcze włączenie udziałowców w projekt edukacyjny, dobre praktyki inżynierii oprogramowania i wymagań, wskazówki, interakcje, zaangażowanie udziałowców w projekt, zarządzanie projektem, analiza i zarządzanie ryzykiem, proces inżynierii wymagań, schemat zaprojektuj / zbuduj / wykonaj / przeanalizuj / przedstaw wyniki, symulacja, jakość oprogramowania, udziałowcy, dostosowanie programu do potrzeb użytkownika, interfejs użytkownika.