IT Implementation in the Educational Process of Future Engineers by means of Project Activities and Competences Assessment

Oxana M. Zamyatina, Polina I. Mozgaleva
Elite Engineering Education Department
Tomsk Polytechnic University
Tomsk, Russia
eto@tpu.ru

Abstract—**Elite Engineering Educational program (EEEP), implemented in Tomsk Polytechnic university (TPU) in 2004 creates the conditions for personal and interdisciplinary competencies formation and provide an opportunity to apply them in practice. The article contains analysis and recommendations to IT that can be involved in project activities while training technical specialists as well as monitoring of the competences formed during the educational process.**

Keywords-planned learning outcomes; assessment of competence; software for the organization of project activities; elite engineering program

I. INTRODUCTION

Project activities at National Research Tomsk Polytechnic University (TPU) is a required and important element of the academic process. It consists of diverse types and forms of organization, levels of difficulty. Project implementation and its review are considered to be a significant teaching method and a type of students' achievements control as well. The objective of project activities at TPU is to increase students' motivation and to prepare them to complex engineering work. Project education is built on the principle of - from basic to advance designing level. The process is organized by integration of training outcome of certain disciplines/modules and knowledge, skills shaping, necessary for engineering problems solving. Competencies development, corresponding with basic educational programs (BEP) objectives, is taking place on different levels of project activities. These competencies are initially laid in project work organized [1].

It was complicated to assess students' competencies, achievements and compare their professional-personality profiles when efficient educational milieu and project activities were under development at National Research Tomsk polytechnic university.

Therefore, there was a need to implement software package into the university portal, to perform functions listed above. The most appropriate location of this software within the portal is "Personal account" - it is an individualized working space for the students and the teachers with limited access. Access is allowed according to the users' status and authority. [2].

The objective of this article is to analyze web-applications which can be used to assess competences and to organize project activities while teaching technical specialists, to make recommendations; including a software package for its further implementation into university portal.

So that achieve the objective we should:

1) Identify the expected results and requirements to project activities arrangement at the university.
2) Specify basic tasks for project activities moderators and decompose them into SW types and modules, which should be implemented into university portal to achieve expected results and to correspond with modern requirements.
3) Choose the most suitable internet-resources for tasks completion.
4) Compare resources chosen to identify the most efficient ones.
5) Recommend software package for further implementation into university portal.

II. EXPECTED RESULTS AND RECOMMENDATIONS

The basic task of junior students' project activities is to form common-literary competences. (CLC): ability to deal with information; ability and preparedness to written and oral communication; leadership skills development; ability to be effective in team and individually, carrying out different tasks; taking initiative skill development and many others. On this basic stage professional competences (PC) are shaped in subjects learnt limits. An important function of basic project activities is to motivate junior students to choose major/specialization in the frames of their academic stream.

Senior students and candidates for master's degree priorities are primarily focused on PC formation (depending on FSES Academic stream, BES TPU Standard requirements and certain BES objectives). CLC continue to develop in advance level projects in correspondence with FSES Academic stream requirements and certain BES objectives. [1].

Project learning is recommended to integrate into all types of educational activities at the university. Project form is identified on the basis of subject area, students' level of

training and results/competences planned to achieve. As a result, future specialist is motivated to get a professionally significant result, while mastering the technology of project and team work, this result will be assessed.

The basic tasks for project activities moderators:

- Develop efficient educational milieu for project activities realization.

- Monitor students' achievements and professional-personal growth at every level of training.

III. SOFTWARE SELECTION FOR ANALYSIS

Taking into account recommendation given, we are decomposing objectives into types and modules so that identify a software package, implementation of which allows a desired goal achieving:

A. References Software

Module A1 Database of research and technology events: conferences, forums, symposiums etc.

Module A2 Servers, inspecting text document to plagiarism.

Module A3 Module 1.3. Search system, indexing full texts of scientific works: publications, dissertations, monograph studies etc.

B. In-built Software

Module B1 Storage, allowing data storing and its sharing with other users on the Internet.

Module B2 Server, translating part of the text or web-page into other language.

Module B3 Resource, which makes a CV.

Module B4 Professional social net helping to find a job and job applicants.

C. Software for team-work

Module C1 Brain storming platform (social nets).

Module C2 Instant files exchange.

Module C3 Cloud data storage.

Module C4 Goal setting, deadlines and their traceability server.

D. Visualization SW

Module D1 Video-hosting server, providing an opportunity to present the results of the work.

Module D2 IP server, allows audio and video telephoning to any part of the globe, arrange video-conferences.

E. Software of competence assessment

Module E1 Soft-skills assessment server.

Module E2 Projects data base, offered for competences development.

Module E3 The list of qualities required to apply for a definite position.

35 Internet-resources with different levels of difficulty were selected. They were chosen on the basis of their capability of tasks solving. They are planned to be used in educational process according to academic areas and modules. There are 3 types of them were identified: elementary, basic and advanced SW.

IV. ANALYSIS OF THE SOFTWARE FOR PROJECT ACTIVITIES

The investigation is based on the analysis of 35 internet-resources with different level of difficulty: easy, basic, advanced. On the results of the research new ideas of data usage were developed. It was assumed that this software can be used to improve students' project work efficiency.

Let us review the analysis of the applications examined and evaluate SW efficiency as a service for research, development and project-oriented students' activities.

Effectiveness of this service will be assessed according to the following scale:

1) Necessary. This application is effective and it is necessary to include it in a software package or to develop an analogue for students' project activities. There are no analogues.

2) Useful. This application is helpful in project work, it is necessary to include it in a software package as one of the services used in students' project activities. This service has analogues, sometimes it is possible to replace with usability internet-resource or application with improved software.

3) Useless. This application is ineffective in students' project activities.

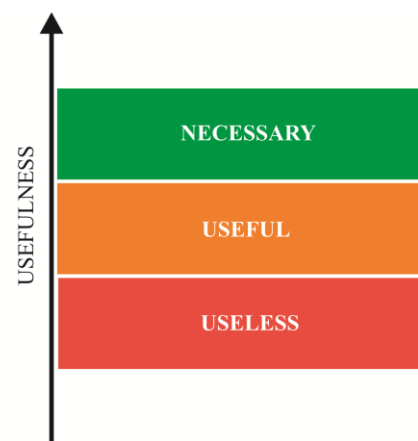Graphically this scale is shown in Fig.1.

Fig. 1. Scale of usefulness

This scale displays efficiency level of the corresponding service, used at students' project work.

The application analysis based on the scale shown above is given in Table I – Table V.

TABLE I. References SW

Description	Module A1	Module A2	Module A3	Reasons	Difficulty	Efficiency
ted.com						
Technology Entertainment Design; is a global set of conferences covering wide range of issues in the sphere of research and practice science and culture [3]	+	-	-	URL of this source can be used in project mapping, as a reference data for the students	Easy	Useful
antiplagiat.ru						
Internet-service AntiPlagiat.ru offers a set of services, which examine text files for the availability of analogues in the net [4]	-	+	-	It can be used as an additional source of articles, papers, reports examination	Easy	Useful
scholar.google.ru						
It is a freely accessible web search engine that indexes the full text of scholarly literature across an array of publishing formats and disciplines [5]	-	-	+	URL of this source can be used in project mind mapping as a reference	Easy	Useful
scirus.com						
It is the most comprehensive scientific research tool on the web. With over 545 million scientific items indexed at last count, it allows researchers to search for not only journal content but also scientists' homepages, courseware, pre-print server material, patents and institutional repository and website information [6]	-	-	+	It can be used as a reference data for the students in English language	Basic	Useful
scienceresearch.com						
ScienceResearch.com is a free, publicly available deep web search engine that uses advanced "federated search technology" to return high quality results by submitting your search query - in real-time - to other well respected search engines then collating, ranking and dropping duplicates of the results [7]	-	-	+	It can be used as a reference data for the students in English language	Basic	Useful
moodle.org						
Moodle - Modular Object-Oriented Dynamic Learning Environment [8]	+	-	-	This application is already used at TPU, project work modules should be developed to implement it into students activities	Basic	Useless
google.ru/alerts						
Google alerts – is a content change detection and notification service, that automatically notifies users when new content from news, web, blogs, video and/or discussion groups matches a set of search terms	+	-	-	Limited functionality of a free version does not correspond with the requirements	Basic	Useless

This type of SW (Fig. 2) contains resources which help to find theoretical base for research or problem-oriented project. Recommended SW: *ted.com* for getting experience in public presentation, *antiplagiat.ru* for making the reference list and verification of text for plagiarism issues, *scirus.com* and *scienceresearch.com* can be used as search systems.
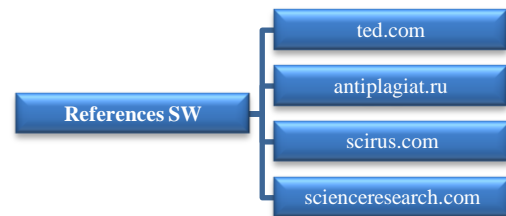

Fig. 2. Recommended SW, «References SW»

TABLE II. In-Built SW

Description	Module B1	Module B2	Module B3	Module B4	Reasons	Difficulty	Efficiency
doodle.com							
It allows work with a calendar in a group or individually [10]	+	-	-	-	This service can be replaced with built-in function of a calendar at the project-builder	Easy	Useful
dropbox.com							
Dropbox is a file hosting service operated by Dropbox, Inc. that offers cloud storage, file sharing with the other users via the Internet [11]	+	-	-	-	This service can be used for files sharing between students and teachers, files storing	Basic	Useful
translate.google.ru							
This resource is a free statistical multilingual machine-translation service provided by Google Inc. to translate written text from one language into another [12]	-	+	-	-	It can be used as an additional application	Basic	Useful
resumup.com							
ResumUP is a service for personal data visualization [13]	-	-	+	-	Developing short and informative resumes of the 1st years students for searching project activities corresponding with their objectives and interests. It can be used in project work to facilitate 1st year	Basic	Necessary

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Description	Module C1	Module C2	Module C3	Module C4	Reasons	Difficulty	Efficiency
					students and research advisors matching. It is possible to make resume for graduates students		
linkedin.com							
It is a social networking website for people in professional occupations. it is mainly used for professional networking [14]	-	-	-	+	It can be used in project work to facilitate 1st year students and research advisors matching. It is possible to make professional resumes for graduates students. Developing short and informative resumes of the 1st years students for searching project activities corresponding with their objectives and interests. This source can be used as an additional one	Basic	Useful
drive.google.com							
It is a free on-line office, that offers collaborative editing on documents, spreadsheets, presentations, it is also a file storage and synchronization service [15]	+	-	-	-	It is convenient for storing and editing of common project files and documents. It can be replaced with project builder function or partially with Dropbox	Basic	Useful
sync.in							
It is a web based word processor for people to collaborate in real-time [16]	+	-	-	-	This service can be replaced with an online mind mapping application that allows users to visualize their thinking using the proven mind mapping method, e.g. Mind42	Basic	Useful
slideshare.net							
It allows upload files privately or publicly in the following file formats: PowerPoint, PDF, Keynote or OpenOffice presentations [17]	+	-	-	-	This service can be replaced with uploading video in social nets, project map, Dropbox	Basic	Useful

The main task of in-built SW (Fig. 3) is optimization of students' project activities and communication between team members, providing collaborative editing and review of documents. *Dropbox.com* corresponds to all these requirements. *Translate.google.ru* can help with translation of scientific article to the foreign language. *Resumup.com* is the most efficient resource in terms of creation of the CV. *Linkedin.com* enables to find the desirable employer.
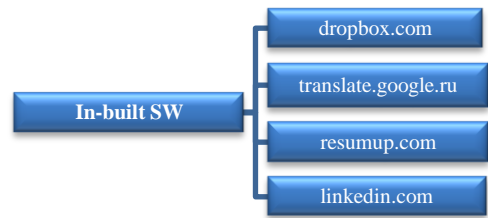

Fig. 3. Recommended SW, «In-built SW»

TABLE III. SW for Team-Work

Description	Module C1	Module C2	Module C3	Module C4	Reasons	Difficulty	Efficiency
dropbox.com							
Dropbox-is a file hosting service operated by Dropbox, Inc. that offers cloud storage, file sharing with the other users via the Internet [12]		+	+		This service can be used for files sharing between students and teachers, files storing	Basic	Useful
mindmeister.com							
MindMeister is an online mind mapping software that allows its users to visualize their thinking, suitable for individual and project work [18]	+	+	+	+ -	It is a fee paying source. It provides users three free fully featured maps, but unsubscribed users' maps cannot be saved	Advanced	Useful
mind42.com							
Mind42 is an online mind mapping application that allows users to visualize their thinking using the mind mapping method. It is a problem-oriented tool aimed at quick data collection, management and editing necessary for mind project mapping [19]	+	+	+	+	It is a free source which does not require special technical requirements, has user-friendly interface in comparison with its analogues. It is very functional	Advanced	Necessary
asana.com							
It is a web-application designed to enable individuals and teams to plan and manage their projects and tasks. It allows users to visualize their ideas [20]	+	+	+	+ -	It is not recommended to add this SW to personal account, as this application has drawbacks while visualizing mind maps of the project. Mind42 is an analogue and has user friendlier interface	Advanced	Useful
facebook.com							
The largest world-wide social networking service [21]	+	+	+	-	It is convenient, but students use it primarily for communication, contains lots of distracters	Basic	Useful

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Description					Reasons	Difficulty	Efficiency
trello.com							
It is a web-application designed to enable individuals and teams to plan and manage their projects and tasks. It allows users to visualize their ideas [22]	+	-	+	+/-	It is a web-application designed to enable individuals and teams to plan and manage their projects and tasks. It allows users to visualize their ideas	Advanced	Useful
xmind.net							
Software that allows users to visualize their ideas [23]	+	-	+	+	It is not recommended to add this SW to personal account, as this application needs to be installed before usage it can cause difficulties and slowdown the project	Advanced	Useful
basecamp.com							
It is a web-based project-management tool. Basecamp offers to-do lists, wiki-style web-based text documents, milestone management, file sharing, time tracking, and a messaging system [24]	+	+	+	+/-	It is a fee paying source. It is recommended to replace it with analogue with similar functionality, e.g. Mind42	Advanced	Useful
teamlab.com							
TeamLab is a multifunctional online service for business collaboration, CRM, document and project management [25]	+	+	+	+	This application is a perfect tool for group project work. It facilitates process, management and reviewing of the project work. It is an alternative to project mind mapping	Basic	Useful
groups.google.com							
It is a free service that supports discussion groups on the Internet [26]	+	-	-	-	It is easily replaceable with in-built chat at project builder	Basic	Useful
google.com/calendar							
It is a free time-management web application, helps to plan events, meetings, activities on calendar [27]	-	-	-	+	Can be easily replaced with an in-built calendar at project builder	Basic	Useful
teamer.ru							
Web-service for team-work on the project [28]	-	+	+	+	This application is suitable for team work on the project. This function can be easily replaced by in-built chat of project builder, e.g. Mind42	Basic	Useful
sync.in							
It is a web based word processor for people to collaborate in real-time [16]	+	-	-	+	This service can be replaced with an online mind mapping application that allows users to visualize their thinking using the proven mind mapping method, e.g. chat of Mind42	Basic	Useful

Description					Reasons	Difficulty	Efficiency
twitter.com							
It is a micro blogging service [29]	+	-	-	-	It does not correspond with the functions required	Basic	Useless

Mind42.com is the efficient useful resource of SW for project team-work (Fig. 4). Key aspects: user friendly interface, functionality, free usage and possibility to save project map. Other recommended resource is *dropbox.com*, which also contains collaborative editing and review of files. This cloud storage is free (important for students).

Fig. 4. Recommended SW, «SW for team-work»

TABLE IV. Visualization SW

Description	Module D1	Module D2	Reasons	Difficulty	Efficiency
zoho.com					
Zoho office suite – is a Web-based online office suite containing word processing, spreadsheets, presentations, databases, note-taking, wikis, customer relationship management (CRM), project management, invoicing, and other applications [30]	+	-	There are fee paying (expensive) applications, switching from one application to another is inconvenient, some are analogues to free applications. It is recommended to replace it with analogue with similar functionality, e.g. Mind42	Advanced	Useful
skype.com					
It provides IP service, allows users to arrange videoconferences, to communicate by voice and video while calling each other via the Internet all over the world [31]	-	+	This service combines some functions required, can be included into complex developed. It is useful for videoconferences, video lectures and seminars arranging	Easy	Useful
youtube.com					
Service provides video hosting [32]	+	-	It is possible to develop TPU channel and upload videos about TPU activities. A reference to the channel should be placed on the main page of the web-site. There is an opportunity for university teachers to upload their video materials, using this application	Easy	Useful
techsmith.com					
Jing – captures anything you see on your computer screen, as an image or short video, and lets you share it instantly [33]	-	-	Limited functionality. These functions can be easily replaced with other applications	Basic	Useless

animoto.com						
It is a web application that produces videos from photos, video clips and music [34]	-	-	Limited functionality of a free version does not correspond with the requirements needed (it is impossible to download the file, 30 minutes time limit)		Easy	Useless
slideshare.net						
It allows upload files privately or publicly in the following file formats: PowerPoint, PDF, Keynote or OpenOffice presentations. [17]	+	-	This service can be replaced with uploading video in social nets, project map, Dropbox		Easy	Useful

The main task of visualization SW (Fig. 5) is to provide the opportunity to deliver students results by means of web-presentation (video-conferences, workshops) and to communicate with scientific community. Recommended SW of this type are *youtube.com* and *skype.com*.
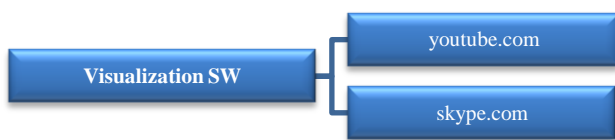
Fig. 5. Recommended SW, «Visualization SW»

TABLE V. SW OF COMPETENCE ASSESSMENT

Description	Module E1	Module E2	Module E3	Reasons	Difficulty	Efficiency
devyourself.ru						
Service that contains: testing and recommending system of personal qualities assessment; database of competences developing projects; the list of necessary qualities for different positions in different companies [35]	+	+	+	This application has a large database of possible competences, provides an opportunity to assess one's abilities. It offers the list of necessary qualities for different positions in different companies	Basic	Useful
360gradusov.com						
Service that allows to assess competences on the Internet. It is handy tool for chief and HR-specialist [36]	-	+	+	It can be useful in improving personal and team performance	Basic	Useful
Resource-K						
Expert system for competence assessment [37]	+	+	+	Helps to assess competence. Commercial, not user friendly, biased competence assessment	Basic	Useful

SW of competence assessment (Fig. 6) will help students to assess their ability and professional competence adequately. Chosen on the basis of the analysis SW of this type are *devyourself.ru* and *360gradusov.com*.
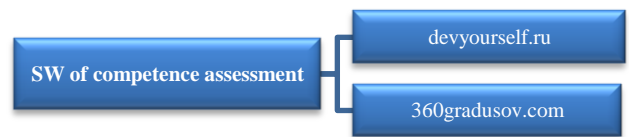
Fig. 6. Recommended SW, «SW of competence assessment»

RECOMMENDATIONS FOR IMPLEMENTATION

On the basis of the analysis made 13 online resources (Fig. 7) were selected for competence assessment and project activities of technical students.
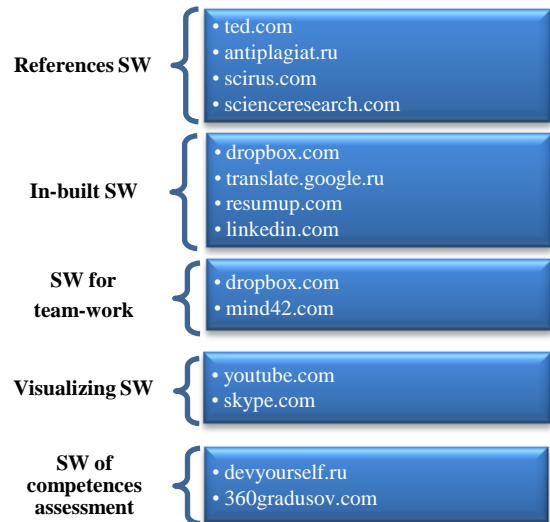
FIGURE 7. Complex of SW for project activities

Software implementation will enable automate project activities of students at the university.

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