Didactic aspects of using virtual laboratories in blended learning

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Abstract — **This paper puts forward a scenario-based programming method for organization and execution of virtual projects with particular attention to design group issues. Only blended courses, where some classes thus far have been delivered by university teachers in teaching classrooms and laboratories have been discussed. Later, they will be singled out and delivered through e-learning sessions using the faculty's e-learning portal. Emphasis has been put on adapting interactive components of the platform to planned interactions, both in teacher-student-teacher and student-student-student relations. Obligatory remote exchange of information among the design team was taken as one of boundary conditions for the project. In this paper, general phrases and suggestions were determined based on example issues of concern, thematically related to planning and organization of distributed computing procedures for local ICT networks, which would enable re-entrant and multi-user numerical computations and data acquisition in real time**

Index Terms – e-learning; blended course;course design; features of moodle; pedagogy of higher education institutions

I. INTRODUCTION

Problem-based learning should focus on deploying acquired knowledge at skills enabling making scientifically sound diagnosis of a problem, proving the innovation behind proposed solutions and undertaking projects leading to an optimum (satisfactory) solution. The issue of achieving satisfactory didactic objectives is a crucial element of education at each stage. Problem-based learning can be delivered through i.a. e-learning, blended learning in particular, which in Polish translations is often referred to as mixed learning. That term captures the essence of education, where used in appropriate proportions are both "traditional learning" and broadly defined modern technology supported education. Please note, that e-learning by definition encompasses all activities supporting training and education through using ICT and multimedia technologies. Clear-cut reference to IT does not give grounds, however, to identify this form of education exclusively with information technologies, as in conjunction with multimedia, they play a solely supportive role, by providing a means to distribute and process data [5]. Blended learning is also a solution facilitating introduction of new educational alternatives to current syllabuses and curricula [2]. Problem-based learning employed at engineering classes might be (and often is) an essential test of how the proposed course scenario is found by participants (students) executing delegated tasks. Based on 25 years of teaching experience of this paper's author, it can be concluded that properly designed projects are in majority perceived positively by students working in groups rather than working individually.

II. DETERMINANTS OF PROBLEM-BASED LEARNING

The problem-based learning methodology with its broad spectrum of multifaceted education is discussed in many publications [1,2,3,7]. Depending on content, execution and type of problems, the following processes can be identified:

- define the problem (*project goals*)
- define detailed problems (*subproblems and tasks*)
- agree on necessary and satisfactory criteria for solutions
- create potential hypotheses (*justifying arguments*)
- verify suggested hypotheses (*counter arguments*)
- evaluate final solutions (*practical and theoretical aspects*)

Characteristic feature of this method is self-teaching, and when combined with working in design teams, positive rivalry. Hence, from perspective of didactic objectives, choosing this particular method is by all means justified. Another advantage of this method is that constant interaction is required and unavoidable, not only between the teacher and design team, but also between all participants of the engineering projects at all stages. Efficiency of self-teaching can be improved through importing suitable elements from other methods, such as: case study, brainstorming, simulation games and mixed games [1,3]. It has also been acknowledged, that solving a problem in hand is only possible - or at least optimum - through deploying procedures carefully selected from rich repository of group problem solving methodologies [1,3,9].

III. DESIGN TEAMS – ALLOCATION OF ROLES

In majority of cases, virtual teams (groups) are created, charged with executing a concrete didactic task, and having done so are dissolved. Depending on project difficulty, a design team should include 5 to 7 students [2,3]. In order to assure adequate coordination of task execution, each student is allocated with a role (function) - corresponding to individual predisposition and interests. It is crucial for the teacher to recognize the overall group ability. According to work by Meredith Belbin [1] - author of self-assessment based concepts - the description of each team role should be accepted by each member of design team. Imposing roles, in majority of cases does not yield expected solutions to the problem in hand (e.g. 3/4 of a 100 teams confirmed that implication).

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Individual roles, specified generally, are the following [1,2,3,7,8]:

- leader (*explains goals and priorities, motivates peers*)
- moderator (*poses challenges, exerts pressures, seeks alternative solutions*)
- executive (*converts ideas and plans into action*)
- innovator (*devises novel concepts, solves demanding problems*)
- resources manager (*explores new opportunities, establishes contacts*)
- supervisor/controller (*all-seeing, evaluates probable outcomes*)
- team player (*prevents frictions, deals with intra-team conflicts*)
- concluder (*searches for mistakes and weak spots of given solutions, supervises deadlines etc.*)

Discussed in this paper example scenarios of problem-based learning in design teams, were all organized according to the above-mentioned specification of roles. It gave grounds for organizing tasks and allocate individual responsibilities to student members of each group. In terms of enriching experiences and evaluating didactic outcomes, the following theses were expected to be confirmed:

- group projects as part of blended learning are methodologically correct
- gaining skills enabling scientifically sound diagnosis of a problem can give grounds for reliable evaluation of a solution
- the effect of competently organized design team work is greater than the collective effect of competent individual actions

IV. Scenarious for Problem-Based Projects

In order to clarify the methodology applied, two scenarios have been illustrated in this paper, both factoring in division into *subproblems* and allocation of responsibilities to participants. The technical assumptions of the first example, stipulated conditions for developing an *INTERBUS* software-hardware suite, featuring among other: the *HTTPSerwer* application, *goWORK* and *MBT* dynamic libraries and programmable PLC controllers. The *HTTPSerwer* application and *goWORK* dynamic library were to be developed using any integrated development environment (IDE), be independent modules operating under the 32 bit Microsoft Windows operating system. Open architecture of the suite was to include the client–server model, whereas the client could be the non-dedicated application of so called thin client. The end-user of the *INTERBUS* system could also use for communication sessions any internet browser installed on a computer with any operating system [9]. That is a valuable solution, particularly so when using free-access computer laboratories – the user does not have to install any software on the local machine. Optionally, the project could have featured integration of the system with selected courses delivered through the e-learning portal hosted by the Faculty of Electrical Engineering, Wroclaw University of Technology. Function block diagram of developed system has been illustrated in figure 2. Four main groups of the INTERBUS suite were particularly paid attention to:

A - communications server application, B - communication interface for constant observation and control, C - components of the programmable WAGO 750-842 PLC controller by WAGO Corporation, D - WAGO applications, for direct (hardware) controller configuration.

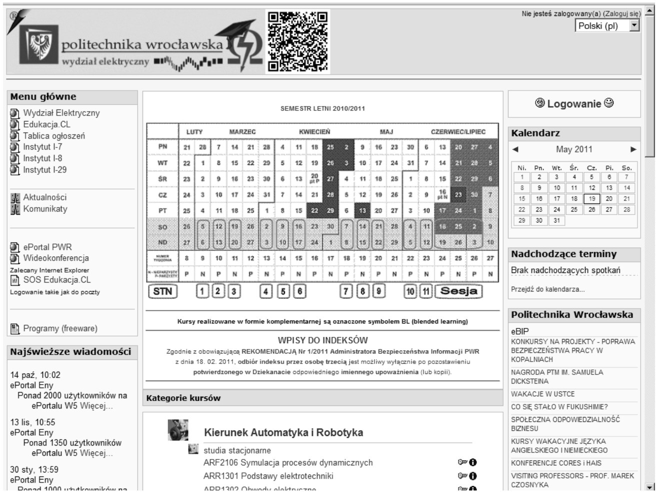

Figure 1. E-learning portal of the Faculty of Electrical Engineering, Wroclaw University of Technology (Polish Website, http://eportal.eny.pwr.wroc.pl)

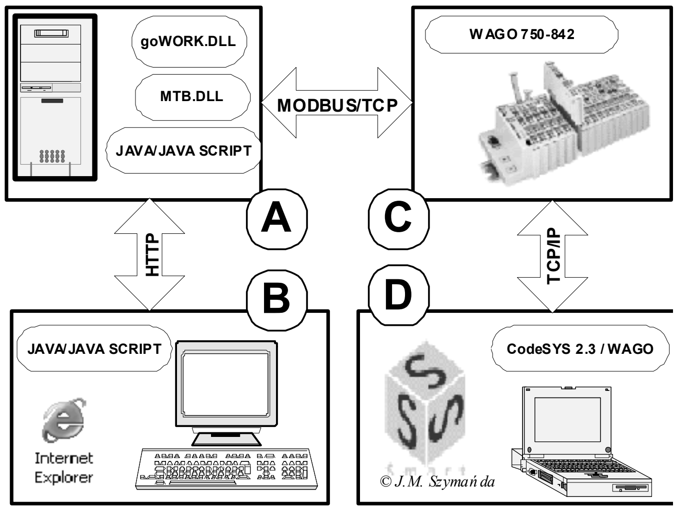

Figure 2. Example functional module of the INTERBUS project

The basic communications protocol of the application layer managing dataflow between point A-B is the HTTP protocol. It enables using the user's standard applications provided there is an internet access. For communication between modules A-C, MOBUS/TCP protocols were encapsulated. Relations between MODBUS/TCP, MODBUS protocols and PLC controllers were specified in documentation provided by WAGO [12]. The necessary basic configuration involving i.a. determining correct parameters of network connections can be entered via the RS232 serial interface or over TCP/IP connection (module C-D).

One of the most important assumptions in the project concerned the didactic aspect of fast control algorithm programming and diagnosing simulated technical problems. Especially enabling design teams to access laboratory equipment controlled by programmable PLC controllers [6] during virtual sessions. All modules of the project were divided and allocated to subgroups. Individual responsibilities - roles in design team - were also defined. Division of responsibilities for functional modules has been illustrated in figure 3.

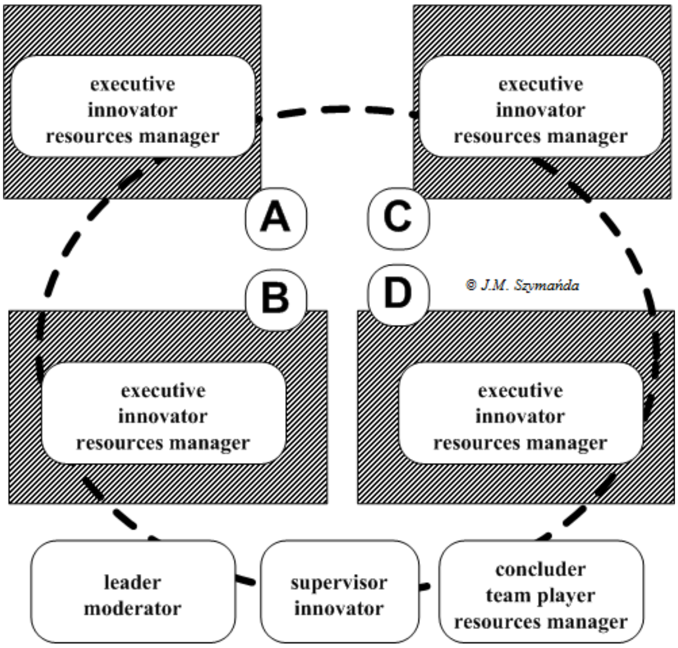

Figure 3. Scenario of selective divisions and allocation of responsibilities (roles)

Second of chosen projects concerned the example issue of concern: "Distributed computing procedures in local computer networks used for data acquisition and computational re-entrance in real time”. The project was to generate a draft schematic of organization and execution of tasks, relational database based on that schematic, and a set of tools controlling and monitoring completion of previously defined tasks (Fig. 4). Similarly to all analyzed and verified scenarios, also here variant divisions and allocation of responsibilities were used. Example projection of roles within design team solving discussed issues of concern has been illustrated in figure 5. Subject to evaluation of virtual design teams in the context of problem-based learning were student laboratory groups taking classes in 2008/09, 2009/10 and 2010/11 academic years. Observed were 5 complex projects, including the two aforementioned. Each of 5 subjects, was repeated over the course of consecutive semesters with little modification. Division of responsibilities assumed in scenarios has been illustrated in table 1. Note, that more than one person from a design team could be allocated with given responsibility as provided in scenarios and specification. Hence the number of roles during tasks can exceed the number of participants.

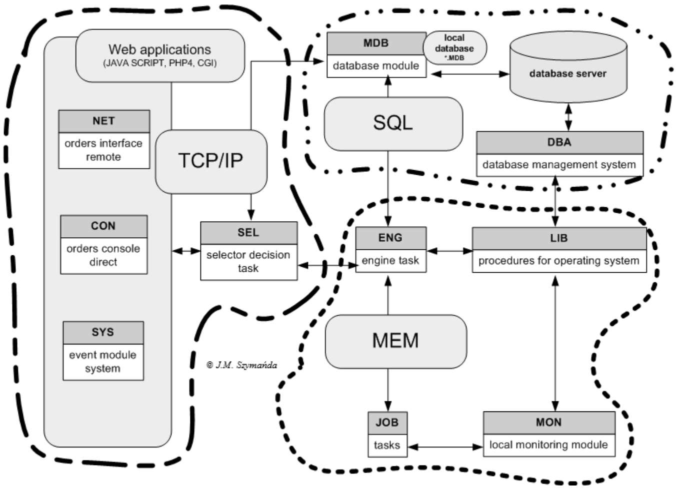

Figure 4. Simplified diagram of dataflow with marked subproblems

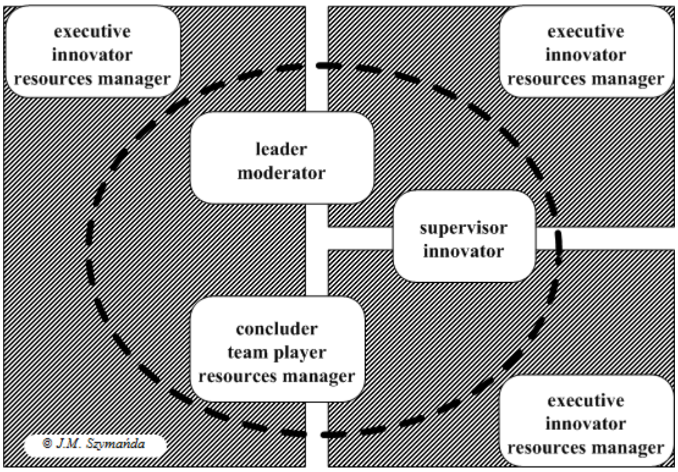

Figure 5. Projection of responsibilities for dataflow diagram shown in Fig. 4.

Carried out observations have clearly shown that quality of project execution depends to a great extent on assumed division of responsibilities. A very interesting observation, was the possibility to compare a given responsibility as a weighting factor used in modeling of input/output systems (neurons), known from programming artificial neural networks. Presentation of selectively aroused design teams upon receiving evaluation of suggested solutions has been illustrated in figure 6. All components of the final mark were checked against assumed and expected technical functionality of each project. It is worth pointing out here, that a project evaluated in a given period (semester) was not taken account of in another period. Detailed analysis of relations observed over that period and ensuing conclusions will become subject of a separate publication [9]. In the context of this paper, figure 7 collates project-related data migration in function of communication means with exchange of data used throughout the process of e-learning.

TABLE I. DIVISION OF RESPONSIBILITIES DURING PROJECTS COMPLETED IN 2008/09, 2009/10 AND 2010/11 *

responsibility / *project number*	leader			moderator			executive			innovator			resources manager			supervisor/ controller			team player/ concluder		
	08	09	10	08	09	10	08	09	10	08	09	10	08	09	10	08	09	10	08	09	10
1	1	1	1	1	1	2	4	4	5	4	2	1	1	2	2	1	2	3	1	1	2
2	1	1	1	1	2	2	3	4	3	4	2	3	1	1	1	1	3	2	1	2	1
3	1	1	1	1	2	1	4	4	5	3	1	2	1	2	1	1	2	1	1	2	1
4	1	1	1	1	3	2	5	4	3	2	2	1	1	2	2	1	3	1	1	1	2
5	1	1	1	1	3	2	4	3	4	1	3	2	1	2	2	1	2	2	1	2	1

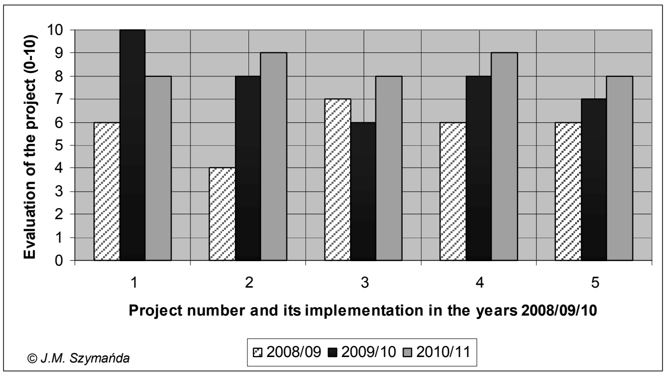

Figure 6. Project evaluations in the context of division of responsibilities (see Table 1)

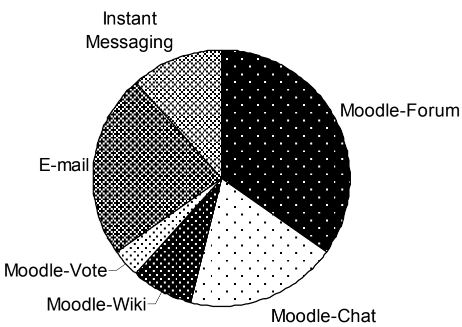

Figure 7. Fraction of data exchange systems during execution of projects 2008-2010

V. CONCLUSION

The proposition discussed in this paper of variant observation of problem-based learning, might become a significant teacher-supporting instrument for didactic scenario planning. Completed tests confirm as correct the methodology of delivering courses involving group engineering projects, part of blended learning [9]. Correct assessment of a design team and thoughtful division of responsibilities considerably improve the potential to acquire skills to make a scientifically sound diagnosis of a problem. The synergy of problem-based learning, group problem solving and correctly allocated individual responsibilities gives best grounds for designing courses using state-of-the-art educational methods and technologies.

REFERENCES

[1] R.M.Belbin,"Management team: why they succeed or fail", Heimann, London, 1981,

[2] R.Clark,R.E.Mayer,"e-Learning and the Science of Instruction", Jon Wiley & Sons: 2003,

[3] M.Robson,"Problem-solving in Groups", England, Gower House 2002,

[4] J.M.Szymanda,"Archiving system and identification of electrical signals",Transactions on computer applications in electrical engineering, XV Conference ZKwE '2010, Poland, Poznan, April 19-21, pp.75-76,

[5] J.M. Szymańda, "The automatic data acquisition in distributed systems teletransmission", Logistyka 6/2010, CD Rom, Poland, 2010, 6, ADE, pp. 3587-3599, ISSN 1231-5478,

[6] WAGO Corp., Modular I/O System ETHERNET TCP/IP, 750-342, 750-842. Manual, nr 750-129/000-002 Version 2.0.0, Poland,

[7] M.Hyla,"Przewodnik po e-learningu", Oficyna Ekonomiczna, Kraków 2005, Poland, (in Polish),

[8] H.Kerzner,"Zarządzanie projektami, studium przypadków", Helion, Gliwice, 2005, Poland, (in Polish),

[9] J.M.Szymańda,"The effectiveness of virtual project teams", unpublished, please email: jaroslaw.szymanda@pwr.wroc.pl,