WEB-BASED ENVIRONMENT FOR DESIGN, DEVELOPMENT AND LEARN WITH PERFORMANCE-CENTERED EDUCATIONAL SYSTEMS

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ABSTRACT
Web-based performance-centred educational system is an integrated environment, which is available via Internet and is structured to provide individualized online access to the full range of information, guidance, advice, data, images, tools and software to permit the user to perform a task. This system is Internet-based Performance Support System with Educational Elements (IPSS_EE). IPSS_EE was developed under a project within Socrates/Minerva European Programme. The performance-centred approach of thinking up an educational system offers new opportunities for the educational and training organizations and calls principle changes in the instructional design of course materials. Developed environment gives up the course designers and teachers a possibility to create IPSS_EE without knowing the theory and organisation behind performance-centred approach. The design, functional and interface model of the Web-system is presented. The main screens from the prototype are shown with examples from course “Electrostatics”, which has been designed and developed in IPSS_EE environment for students from physics-engineering speciality. Experimental design of pilot test of IPSS_EE is described.

KEYWORDS
Performance support systems, Web-based education, Web-based instructions, Web-based environment, performance-centred approach

INTRODUCTION

In the "traditional" Web-based education usually the expository deductive instructional strategy is used. The engineering education involves the use and application of skills for finding solutions, making decisions, and thinking effectively, i.e. we need to use instructional strategies and tactics for problem-solving skills in the design of educational systems for engineering education. These educational systems implement inductive strategy in an intelligent computer-assisted instruction (most related to problem-solving).

A typical performance-centered Internet-based integrated environment provides a combination of the following capabilities (Gery, 1991): reference information about a task or closely related set of tasks; task-specific training; expert advice about a task; automated tools for task performance.

Reference information describes the task that the user has to perform. This reference information supports the user by making immediately available information, which (s)he previously had to memorize or look for in a book or a manual. The reference section allows the user to learn more deeply about a given task and is always available for her/him to read and *provides the theory behind the task it supports*. Task-specific training reduces preliminary training by helping the user to learn while performing the task. This type of *training is learner-centred* because the learner asks for help when he needs it to perform a task, and the help gives him the specific information that (s)he requests.

Educational performance support systems contain specific advice on performing tasks and it is its greatest advantage. The advice is usually provided by an *expert system*. Automated tools for task performance are most helpful when a supported task involves the use of *specific software*.
This new approach of thinking up the educational system as an IPSS, offers new opportunities for the educational and training organizations and calls principle changes in the instructional design of course materials (Mileva, Tzanova, 2000).

DESIGN MODEL OF IPSS_EE

The Design Model of IPSS_EE (Fig.1) presents main steps and activities that the course designer has to undertake preparing the course, presented and structured as IPSS_EE, and obtained results from these activities. The results are input data for the IPSS_EE Editor, which aimed to fill the IPSS_EE data-base, giving up the course designer a friendly and useful environment to do this.
The first step in the Design Model is to define the subject matter domain in a form of knowledge model. In educational contexts, the domain is a subject area and for the domain analysis we have to define the domain and identify and list all tasks that comprise the domain. For defining the domain the designer has to identify main concepts in the domain and their relations; materials that allow the user to learn more deeply about a given concept and provide the theory defining the concept; additional information, software, good examples and instructions.

The next step in the Model is to state the objectives to define the desired learning outcomes in terms of a measurable learner performance. In this step objectives are stated on the level domain objectives.
The next two steps continue the process of defining the domain of learning and lead to the well defined tasks for performance – list with tasks for performance, activities to be operated upon in each task and tools to be used. The transactions define the tasks that gain each of the objectives. The following information will be required: major ways that the concepts are likely to be used by or useful to the learner; major competencies that are part of the concepts; any tools that are used in the performance of each task; any objects that gained during performance of each task.

The result from the transactions is a list with all tasks for performance, mastering the domain. The designer has to think of, list and arrange all tasks in the optimal procedural order, avoiding duplication of tasks. Then he has to determine any paths trough tasks in order to gain each objective, sequence the paths and organize them into modules.

For each task for performance the designer has to identify instructions for task performance, software for task performance and direction for using software for task performance purpose.
One of the most important parts of IPSS_EE is the Expert advice. Expert systems allow expertise of the few to be disseminated to the many. They do this by encoding an expert's knowledge in discrete, declarative 'chunks' of knowledge, without the need for conventional programming. A reasoning engine applies that knowledge to specific cases by having information from the course designer. The reasoning engine, using the knowledgebase, probes the user for information about a particular situation as needed, and finds the appropriate recommendations for that user, based on their situation. For IPSS_EE purpose we use *Knowledge Wright* (www.amzi.com) as a tool for creating expert system for each of the Modules. The course designer has to prepare for Knowledge Wright workshop a set of possible problems or trouble shootings, and for each of them – symptoms and solutions. The IPSS_EE Administrator uses this information to structure and organize Expert Adviser of IPSS_EE Modules, working in the Knowledge Wright Workshop environment.

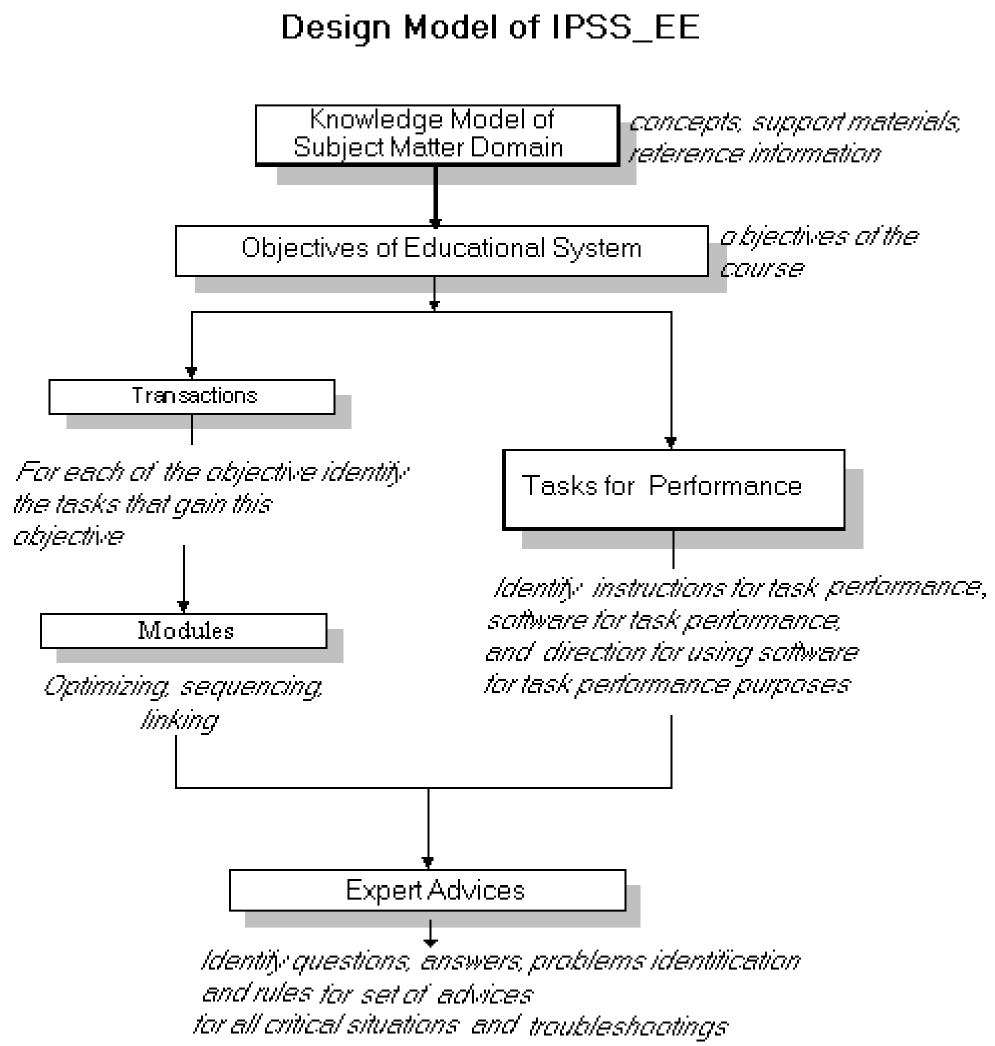


Figure1

FUNCTIONAL MODEL OF IPSS_EE

Developed environment contains three components: *IPSS_EE Editor*, *IPSS_EE Administrator* and *IPSS_EE Student Area*. The main structure and connections between three components are presented on Fig. 2. Course designers, using IPSS_EE Design Model, can prepare all necessary materials for creating IPSS_EE for a specific subject area. They, with help from subject matter experts work in IPSS_EE Editor environment and present all materials (input or copy/paste text and objects in text fields, or browse files in different formats) as elements of IPSS_EE. The Save action in IPSS_EE Editor fills automatically IPSS_EE data-base on the server (Fig.3). The purpose and the advantages of using IPSS_EE Editor to develop IPSS_EE for a specific subject area are:

- the course designers and subject matter experts have to know only the IPSS principles, components and functions, and not the IPSS theory and organisation behind them;
- developed IPSS_EE are with preliminary designed and approved structure and interface;
- IPSS_EE Editor is user friendly and easy to navigate;
- IPSS_EE Editor offers a possibility the existing, preliminary developed course materials to be adopted as elements of IPSS in a very simple way;
- the time for development is considerably reduced.

IPSS_EE Administrator is the system that allows an authorized person to read the information about problems, symptoms and solutions for specific IPSS_EE module and to create the model of the expert

system (goal, questions, set-rules and diagnostics), and then to input this model in the Knowledge Wright Workshop. The result is file with expert advices, which can be embedded in the IPSS_EE Student Area application.
The advantages of using IPSS_EE Administrator to develop expert advices for a specific IPSS_EE module are:

- avoids one of the major difficulties with building expert system/knowledge bases - the sort of non-precise knowledge varies widely from one problem domain to another;
- avoids the problem with the way in which the knowledge is applied (they varies);
- helps to integrate the expertise with other sources of information.

KnowledgeWright is designed to be easily adapted to any sort of domain expertise, type of reasoning, collection of supporting data, types of actions triggered, and deployment. This means KnowledgeWright can be configured to provide a near-perfect knowledge development, test, and deployment environment for a given domain of expertise.

Learners work with IPSS_EE Student Area – this is IPSS_EE for a specific subject area, with preliminary defined from the IPSS_EE Editor structure and automatic developed from data on the IPSS_EE Server. The main area that this part is concerned with is the Task performance environment, where the learner can perform the task using applications/files or simulation activities (Fig.4). Other links provide access to other parts of the IPSS_EE that help the learner to perform the task – task-specific training, instructions how to perform, reference information, software for task performance and expert advices for problems and trouble shootings. Each of these parts is presented in a new window, opened on the working environment (Fig.5). The rationale behind this is:

- to allow learners to access the elements of IPSS_EE quickly;
- learners generally see themselves as on a work place rather than in a classroom;
- the learner doesn't loose the assumption that the main goal is to perform the task and the links are used to increase the quality of this performance.

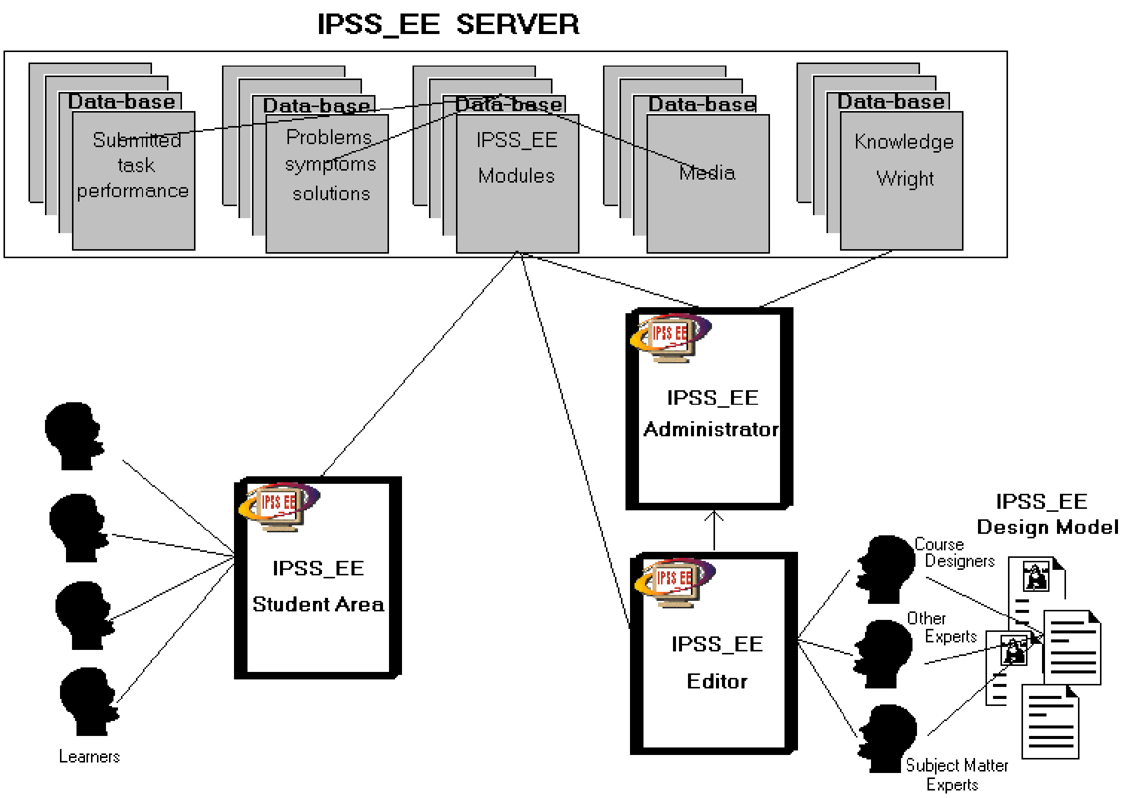
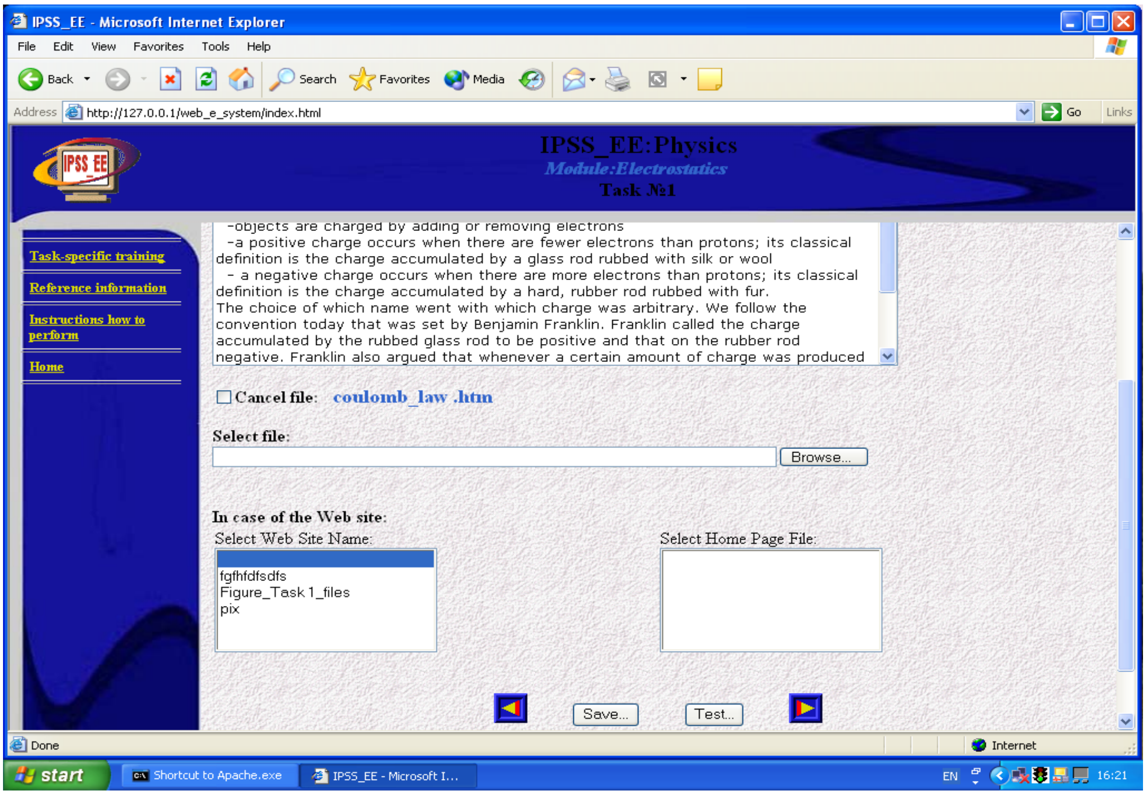


Figure 2



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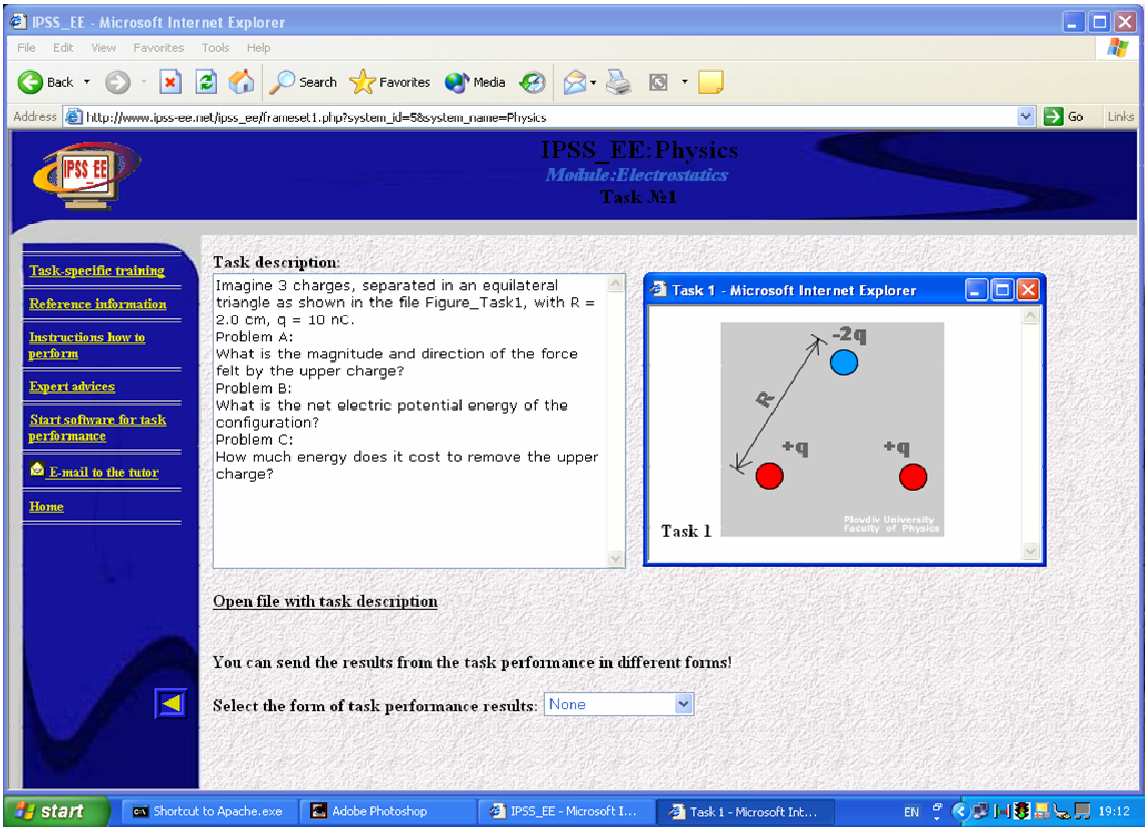

Figure 4

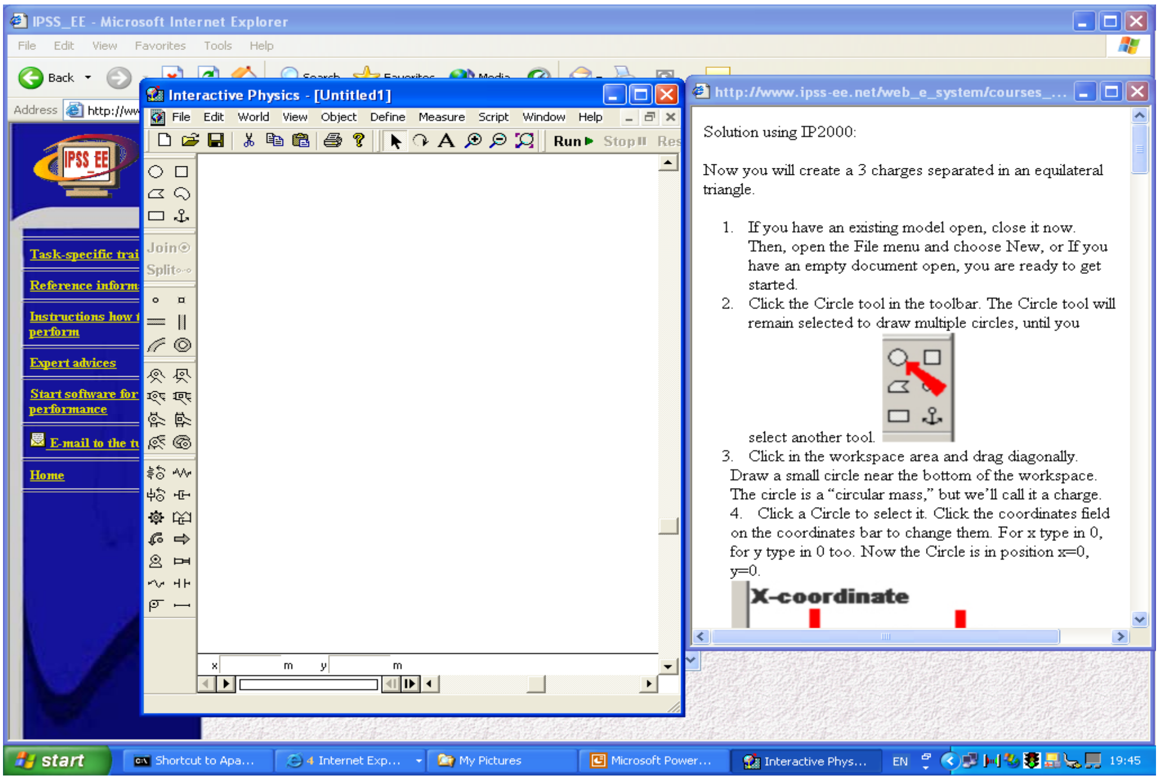

Figure 5

EXPERIMENTAL DESIGN

One of the main objectives is to set up *comparative analyses* for improving the understanding of learning processes and experiences in using ICT. The hypothesis is that the learning in an Internet-based environment with PSS_EE proves pedagogic effectiveness as indicated by performance, attitudes and perceptions of students. The sub-hypotheses are:

- This new learning environment offers opportunity for University structure (department, faculty) to recognise the importance of managing and collecting its students' experience, and derive from this experience the useful and new features and transform them to the knowledge for the new learning.
- As a new technology, IPSS_EE will move the traditional teaching to the closely related to the job learning. In this point, these systems have a strong potential to help students mastering job-related skills.

For the pedagogic effectiveness of the new courses an *experiment* with pilot groups of students is planed. The experiment is performed during the *pilot test* and the field trials. The pilot test is conducted with small groups of students form the PU, TCP (Bulgaria) and INPG (France). In the field trial larger groups of students from PU, TCP, TUS (Bulgaria), UNED-DIEEC (Spain) and INPG (France) will participate. During the tests two samples of students work on the same content, one – performing tasks in IPSS_EE and the second - with traditional lecturing and laboratory practice methods. By the end of the experiment the mean score and frequency distribution of the marks on both, knowledge test and performance on project development will be compared. The information on the attitudes and perceptions of the students working with the Internet-based modules will be collected and records of communication files. The scheme of our Experimental design is presented on Fig.6, where: **O1** is questionnaire (pretest); **X1** is treatment (traditional); **X2** is treatment (IPSS_EE); **O2** is questionnaire (posttest); **O3** is test (product); **O4** is test (learning); **EG** means experimental group; **CG** means control group.

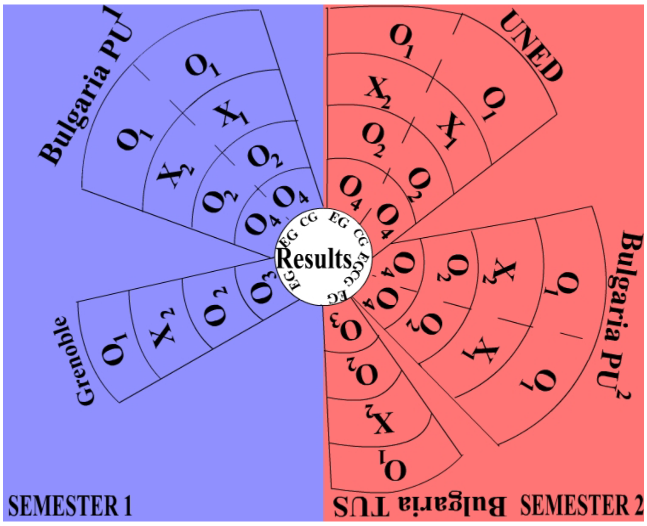

Figure 6

In the experiments different groups of learners are involved (1) of different gender and nationality, speaking four different languages, (2) regular students from traditional universities, which work in an open scheme, and students of one university for distance education, (3) regular students of one college. So, the expected results of the analyses of learners' attitudes and profiles, of the impact of task-performance eLearning on learning processes will be *representative* and will get a better insight of what is to be transferred and how, and finally will contribute to the successful implementation of the IPSS_EE.

Procedure

A rough prototype of what the procedure eventually may include is as follows:

1. Three equal of size groups should be randomly formed out of the population of engineering students with a particular grade at each partner institution. The number of students in each group should not be less than 15.
2. The three groups then are randomly assigned - one to the experimental condition and two to the control conditions.
3. Students of the three groups are asked to fill in the learning style questionnaire or style inventory.
4. The experimental group work with the IPSS_EE. One of the control group studies via web-based traditional instruction. The students of the second control group are put in traditional classroom setting. The learning materials and the study time are the same for the three groups.
5. After learning session, students conduct a test to measure the level of their knowledge and performance. They also fill in a semantic differential for their attitudes toward the instructional approaches.

Data analysis

To report that the differences between the experimental and the two control groups is due to the IPSS_EE approach instead of chance factors, one-way- analysis of variance (ANOVA) statistics is applied. ANOVA as an inferential statistics contributes to the elimination of possible alternative explanation related to chance error. ANOVA is preferred in the expense of typically used t-tests because the experimental design of this study includes some mediator variables. In addition a regression analysis should show whether the mediator variables affect the main effect of independent variable (instruction approach) on dependent variables (performance test and semantic differential).

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Note: The URL address of the IPSS_EE environment is: www.ipss-ee.net links IPSS_EE Editor and IPSS_EE Student Area. In IPSS_EE Student Area you can find demo course "Physics"

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