A STUDY OF PROJECT-BASED INSTRUCTIONAL SYSTEMS DESIGN(P-ISD) MODEL DEVELOPMENT FOR ENGINEERING PRACTICE EDUCATION

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Abstract *-The purpose of this study is to provide a P-ISD model to the engineering professors and teachers to improve their theoretical and practical performance on technical and non-technical concepts.. Also, the other purpose is to let them recognize the importance of a P-ISD model as an individual and social transformational agent. Current debates in engineering education are focused on the need for additional social knowledge, skills, and attitudes to cooperate with group members. Education and training of new engineering practice education are major challenges against current and future engineering practice education. So far, most of instructors have thought that students will acquire non-technical skills more or less automatically while performing their projects. Because of this reason, there has been an emphasis on engineering practice education re-design. The needs on new engineering practice education were initiated in vocational and engineering areas to introduce new knowledge, skills, and attitudes. A good way of learning technical and non-technical knowledge, skills, and attitudes could be the introduction of a P-ISD model for project work. The objective of the P-ISD model development will be to provide a guideline constructing the process of teaching and learning to instructor and students. Another objective of the P-ISD model development is that it has been showing good results and so it has also contributed to the performance of engineering practice education.*

Key words: Project Based Instructional Systems Design(P-ISD), Engineering Practice Education, and non-technical concepts

1. Introduction

Two goals in engineering education have been focused on the need for technical and non-technical skills to work in the real world. Especially, training of such additional social and methodological skills is a major challenge for future engineering education[1]. So far the opinion has prevailed that students will acquire non-technical skills more or less automatically while learning in their projects. But all of these opinions are not true. Therefore, professors and teachers must design very carefully their project programs to acquire technical and non-technical skills. Instructional Systems Design is the science of creating detailed specifications for the development, evaluation and maintenance of situations which facilitate learning outcomes. Project-based instructional systems design (P-ISD) model could provide and develop a strategy of simultaneous training technical and non-technical skills to ensure that students experience and reflect these skills through engineering practice education. In this sense, this article does not seek to define a model that may be adopted for analyzing the quality of a P-ISD, but rather offers the opportunity for careful consideration of the many elements affecting quality.

2. Project method in engineering practice education

New technologies and manufacturing industries lead to changes in the demands made on skilled workers. In this view, it is particularly important to teach students to regulate their own pace of learning and to act independently. The project method is one of the standard teaching methods [2] to acquire these kinds of knowledge and skills. Whenever teaching methods on constructivist concepts, inquiry-based learning and problem solving are discussed in vocational and industrial education as wells as in other fields, the project is considered to be one of the best and most appropriate methods of learning and teaching. Also, it is generally considered a means with which students can develop their own knowledge and skills as well as independence and responsibility, and practice social and democratic modes of behavior [3]. Project-based learning and teaching has grounded the strong foundation of the constructivist philosophy of education. Constructivism tells us that students construct knowledge and skills as they learn, and, in order to learn, students must discover for themselves the knowledge that they need. Professors and teachers may, of course, act as guides and facilitators in the process of helping students figure out prior knowledge, knowledge to be sought, and the meaning gained from self-assessment and reflection. Beyond project-based learning is much more than simply “doing a project”, they must prepare very carefully all processes of learning and teaching.

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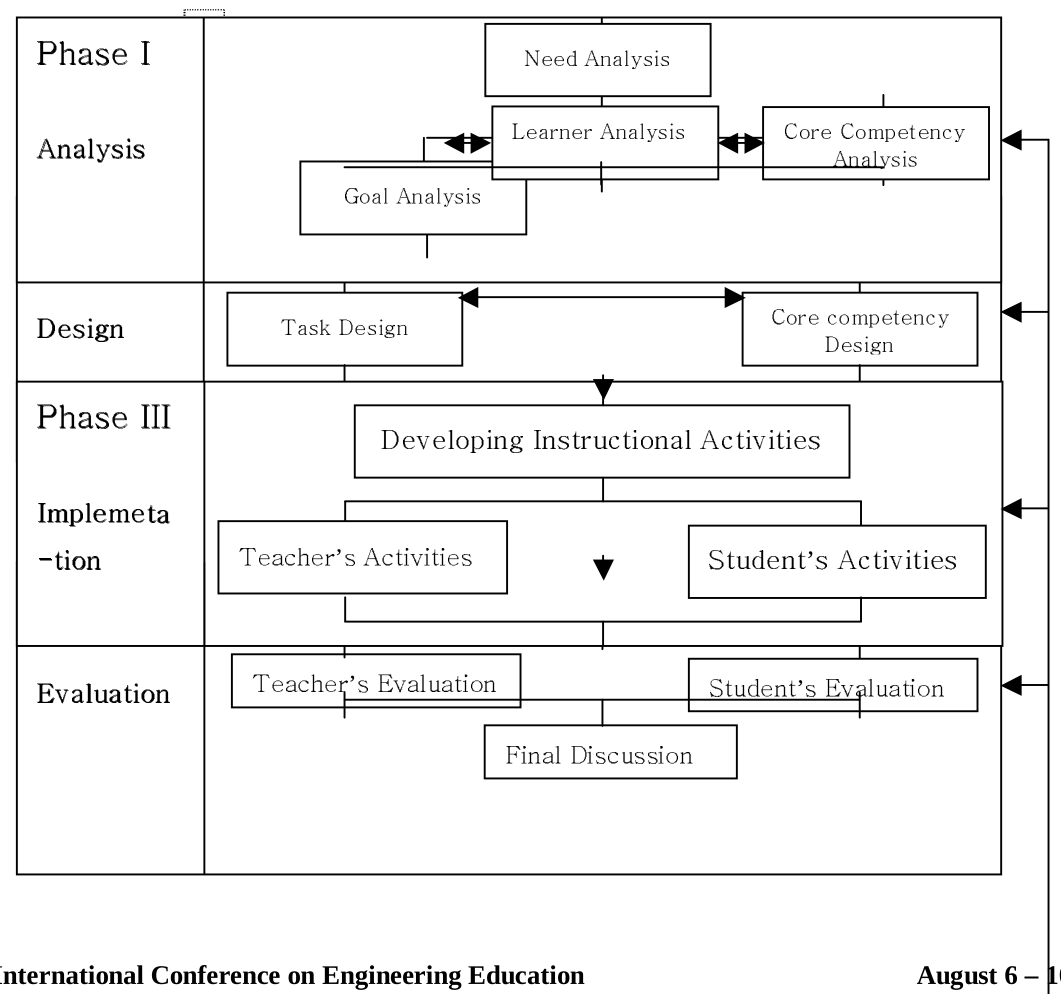
3. Instructional Systems Design strategy for learning-teaching

Instructional systems design is the process of solving instructional problems by systematic analysis of the conditions of learning. Also, it is the science of creating detailed specifications for the development, evaluation, and maintenance of situations which facilitate the learning outcomes [4]. The purpose of designed teaching -learning is to activate and support the learning of the individual student. This aim is a characteristic of instruction wherever it occurs, whether between a tutor and a single student, an adult-interest group, or in an on-the job setting. Instruction for the support of learning must be something which is planned rather than haphazard. The learning it aids should bring all individuals closer to the goals of optimal use of their talents, enjoyment of life, and adjustment to the physical and social environment. Naturally, this does not mean that the planning of instruction will have the effect of making different individuals more alike. On the contrary, diversity among individuals will be enhanced. The purpose of planned instruction is to help each person develop as fully as possible, in his or her own individual directions. There are several basic assumptions about instruction design [5]. First, ISD must be aimed at aiding the learning of individual. Second, ISD has phases that are both immediate and long range. Third, ISD systematically designed instruction can greatly affect individual human development. Fourth, ISD should be conducted by means of a systems approach. The final assumption is that designed instruction must be based on knowledge of how human beings learn. The P-ISD model was developed for carrying out steps in the process, such as methods for defining what is to be learned, for delivering instruction, and for measuring outcomes. Therefore, a P-ISD model would be also developed for carrying out each steps in the process of learning and teaching and verified its steps and all processes.

4. Project based ISD model

A P-ISD model(figure 1) might be divided into four major phases. Also, these phases include several fields, each consisting of several activities.

Figure 1. P-ISD Model



Phase I: Analysis

This phase would be perhaps the most critical phase of a P-ISD model, because it is here that the foundation is built for the remainder of the process. The first phase will be divided into three steps, goal analysis, learner analysis, and core competency analysis. All These steps are interdependent.

1. Goal Analysis

Activity of goal analysis will be divided into determining project goal and analyzing the project goal, and determining subordinate knowledge, skills, and attitudes. The first step in this activity is to determine what it is that the trainer wants learners to be able to do when they have completed their project. The definition of the project goal may be derived from a list of goals, from a needs analysis with regard to a new knowledge, skills, and attitudes. The second step in the activity is to analyze the project goal. Students have identified the project goal and they will determine step-by-step what students are doing when they perform their goal. The final step is to determine what skills, knowledge, and attitudes known as entry behaviors, are required of students to be able to begin the project.

1. Learner Analysis

Learner analysis is to identify the general characteristics that members of the target population bring to the instruction. Useful information includes prior knowledge of the project topic area, entry behaviors, attitudes toward content, academic motivation, education and ability levels, general learning preferences, and group characteristics. Much of the current learning researches emphasize the important of recognizing what learners already know about the topic that will be targeted. Also, target learners must have already mastered certain entry behaviors associated with learning the goal prior to beginning instruction. Therefore, the trainers must identify the range of prerequisite and prior experience, knowledge, and attitudes towards the content area that will be covered in the instruction.

3. Core Competency Analysis

New technology and Manufacturing processes lead to changes in the demands made on skilled workers. In this connection, it is particularly important to teach trainees to regulate their own pace of learning and to act independently. To take these demands into consideration in training, Simens AG developed “PETRA” in a pilot project sponsored by the Federal Ministry for Education and Science. PETRA stands for project and transfer-oriented training which focuses on the following essential areas:

1) Organizing and carrying out the practice-task
   a. determination
   b. accuracy
   c. systematic course of action
   d. organizational ability
   e. coordinative ability

2) Communication and cooperation
   a. open mindedness
   b. ability to cooperate
   c. Intuition
   d. appropriate behavior toward customer(s)

3) Application of learning techniques and interrelated thought processes associated with the work in question
   a. using learning techniques
   b. deductive thinking
   c. transferability
   d. thinking in systems

4) Independence an responsibility
   a. involvement
   b. reliability
   c. acting prudently
   d. ability to criticize oneself
   e. putting forward one’s own opinion

5) Ability to work under stress
   a. ability to concentrate
   b. perseverance
   c. adaptability

Phase II: Design

After completion of the analysis effort, the design phase begins. This phase includes: selecting adequate competency, developing objectives and tests, describing student entry behavior, and determining the sequence and structure of the project based learning. All these steps in this phase are interdependent.

1. Task and Core Competency Design

1) Writing Objectives

The first step in phase II is developing objectives. This is where the writing of terminal learning objectives for training takes place. Job tasks which training must be provided have been identified in the first phase of the P-ISD model. Now it is necessary to translate these tasks into objectives for which instruction can be designed. One of the main goals of the teacher at this point is to ensure a direct transfer of knowledge and skills from the training world to the job world.

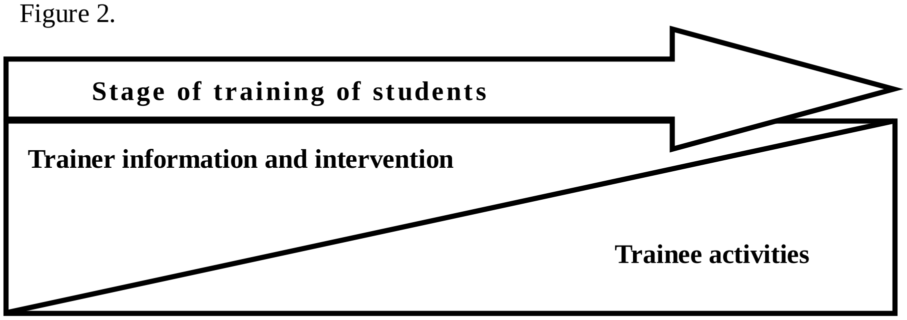
2) Developing test items

Once the objectives have been developed, the next step is to develop the tests which measure the desired behavior specified in the objectives. There will be a direct correspondence between the objectives and the test: That is, there will be at least one test item to measure each of the principal objectives.

3) Developing sequence and structure
The final step in the task design is deciding sequence and structure. Sequence and structure refers to the organization of objectives so that each step in the instruction can build on what has been previously learned. If learning one skill is dependent on first learning other skills, then that sequence is specified here. Related learning objectives are then grouped together to simplify the development of the instruction.

Phase III. Implementation
Self-regulated learning is of utmost importance in project-oriented training. As students pass from one stage to the next, they systematically learn to plan independently, carry out specialized tasks and assess the results. Development of the core skills is given attention throughout.

Figure 2.



1. Implementation of teacher's and student's activities
At the beginning, the teacher regulates the learning process directly through instruction, didactic skills, and the like. As students gain experience, the teacher slowly reduces his own activities. That is to say, he provides less information and intervenes less, allowing students to regulate their learning themselves with the help of leading questions and pointers, hand-outs and other work aids. Table 1-1 displays the role of teacher and students in practice education.

Table 1-1. The Roles of teacher and students in practice engineering education

	Step	Student's role	Teacher's role
Step 1	Providing information	Determining of the group type	Providing objectives, task, guidance, and information sources
Step 2	Planning the procedure	Developing the work schedule	Providing work schedule form
Step 3	Reaching a decision	Support the decision	Discussing with group member(s)
Step 4	Carrying out the task	Carrying the task Carrying the formative evaluation	Discussing the results Providing advice
Step 5	Assessing the results	Assess his/her own work	Check and complete the assessment
Step 6	Final discussion	Discuss the technical results and core skills with students	Discuss the technical results and core skills with students

Phase IV. Evaluation
After each practice-task , students assess their work results using the checklist themselves. Following this, the professor or teacher checks and completes the students' self-assessment. While the practice-task is being executed, the professor or teacher keeps a continuous group observation journal in which he notes down his observations on the work-steps. Also, he structures them according to the core skills.

5.Conclusion

This is a time of unprecedented and rapid change as powerful forces are reshaping the world around us. Higher education is confronted with breathtaking new challenges and opportunities[7]. In particular, engineering education is among those most affected in this rapid transformation. So, engineering programs in modern universities and vocational schools are necessary to keep the balance between specialized technical skills and non-technical skills. The instructional process has traditionally involved instructor, learner, and textbooks. The content to be learned was contained in the text, and it was the instructor’s responsibility to teach that content to the learners. But, the role of instructor’s has changed and the instructional approach calls for more roles of students results to enable a learning environment where students construct understanding in authentic contexts, rooted in the needs of practice. Careful approach of ISD for alternative engineering (practice) education is necessary to acquire technical and non technical results and to enable successful teaching and learning.

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