European Research Studies,
Volume XVIII, Issue 4, Special Issue, 2015 *pp. 171 – 177*

Experience of Universities in Practice-Oriented Training Personnel for High-Tech Enterprises

Y.M. Borovin[1], E.V. Krylova[2], A.D. Shlyapin[3]

Abstract:

Different options have been considered of work-based learning (WBL) in Russian and foreign universities. Special attention is given to the variant of PBL - project learning (PL) on training bachelors. Basic concepts and principles have been discussed dealing with the organization of PL developed by Aalborg University - one of the founders of this teaching technique. The advisability is shown of organizing special courses of introduction to project learning in the first two semesters.

***Key Words**: practice-based learning, project learning, enterprises, faculty, students, administration.*

[1] Candidate of Technical Sciences, Associate Professor, Vice-rector for Research of Moscow State University of Mechanical Engineering (MAMI), borovin@msiu.ru
[2] Candidate of Pedagogical Sciences, Associate Professor, Deputy Director of Industrial Technological Institute of Moscow State University of Mechanical Engineering (MAMI), ctv-msiu@yandex.ru
[3] Doctor of Technical Sciences, Professor, Head of Materials Science Department of Moscow State University of Mechanical Engineering (MAMI), shliapin@msiu.ru

Introduction

Taking into account the nowadays realities, the transition of universities to the "work base learning" (WBL) is imperative whereas many teachers declare the successful use for a long time of certain elements of this teaching method. Thus, in the second half of the last century one of the authors, being a third year student of Moscow Institute of steel and alloys in the group of five students of one specialty according to the decision of the academic council was transferred to individual curriculum with free attendance. All students in this group studied special magnetic materials and each one already had research topic, scientific advisor and certain achievements. Each student of this group obtained special curriculum approved by the University academic Council from which quite a lot of disciplines were withdrawn, not in fact necessary for the profession. Instead of withdrawn equal or greater number of other special disciplines were added, some of which was supposed to be studied at other institutions. Time released due free attendance was designed for additional courses and scientific work according to the planned project.

The above model of educational and scientific work of students is a limiting case of individual project work and its individuality is the only drawback. The advantage of the model was a good linkage of the project topic with the curriculum. It should be recognized that, in general, all participants in the work program were overloaded, in some cases significantly, but in the presence of a free attendance it was quite tolerable.

The experiment described finished quite successfully: two participants continued their education as postgraduates, the rest were distributed to the best specialized academic and branch research institutes.

This model can be easily improved. So individual project-based learning described above can be transformed into a team project learning by giving more complex task to the group of 3 or 4 students. Maybe one should start using this method avoiding 100% "coverage" and select applicants individually, on a voluntary basis, emphasizing to the "volunteers" great personal responsibility. In the same years in Moscow Institute of steel and alloys another component of the project-based learning was successfully implemented. It was a particular type of laboratory works on special courses that do not guarantee known result in advance. The model of such project-based learning is well illustrated in the following example, taken from actual practice of the Department of metallography, 1972. The group of students of 3-4 people were asked to obtain magnetically hard material with a specified interval of magnetic energy. In this particular case, the task was allocated 6 hours = 4+2 with an interval of a week, because of long heat treatment required technologically. During the second laboratory work the teams measured the properties in the presence of a teacher and defended the technology applied in the work.

If desired, any special laboratory work can be transformed into project. This, of course, will inevitably produce some problems for the learning Department, since the duration of laboratory work-projects can be much larger than traditional laboratory work, but the benefit will be much higher. It is also clear that the specificity of training areas will affect the organizational scheme of such works.

At the end of the excursus into history the pre-diploma practice at the Institute of steel and alloys should be mentioned. As a rule, they were carried out at leading companies or research institutes. With rare exceptions, students were given the themes of real projects, the results of which were often taken as a basis for further graduate work.

Speaking about well-known in Russian higher education models of work-based learning we should first of all mention the vtuz- plant system adequate to the cooperative study in USA. This system over 50 years has successfully trained the staff for leading machine-building companies. In this model, the practical part of the training, most of which was the full-time work, was also an integral part of the educational process according to different schemes: week-week, semester-semester and others. In some cases due to a favorable attitude of the enterprise administration the work-oriented training became the project-based learning. Such cases occurred when the management considered the students not only as skilled field staff with routine work, but also as prospective employees who can be entrusted with the resolution of problematic issues facing the production area.

Some of the concepts and principles of project-based learning

Since the second half of the last century the project-based learning became a popular topic in educational sciences. There are universities which made the project-oriented model the university standard and related with this the growth of their popularity. So, since the establishment in 1974 the Aalborg University it manifested the interest in alternative approaches to education giving students more active role in the acquisition of knowledge and achievement of high academic standards. The need was declared in redefining the role of teacher in the learning process. Instead of simple transferring the knowledge to students the teacher had to become the initiator and facilitator of collaborative processes of production and development of knowledge thus giving a certain synergistic effect. As a result, the University of Aalborg adopted the project learning model (Project-based Learning). Let us consider some of the basic concepts and principles of project-based learning, declared in the Aalborg model.

Project courses are the courses within the curriculum which relate directly to the themes of project work. Students choose a particular project course basing on its relevance to the project.

Educational course is a part of the basic curriculum that introduces students to the fundamental concepts, theories, or skills in a certain discipline. These courses are assessed separately from the project courses and project work.

Implementing the Aalborg model the University should demonstrate its constant commitment to main principles: problem orientation, project organization, integration of theory and practice, motivation of participants, team approach, cooperation and feedback.

With regard to *the integration of theory and practice* the curriculum, teachers and project leaders should help the students to apply the specific results of the design work for the extension of their theoretical knowledge. The students have to see the correlation between theories and empirical/ practical knowledge. With regard to *collaboration and feedback*, the students should use the criticism of peers and teachers to improve their work; the skills of collaboration, feedback and expression are important results of implementation of the project learning model.

The experience of using the project learning model has shown that its implementation cannot be effective at the course level, because the resulting benefits cannot offset the disadvantages associated with the violation of the educational process within the course.

All PL programs in the first year should include training, orienting students to problem - and project-based educational model. This may include the identification and formulation of problems, project management, conflict management, team-building activities. In addition, students should obtain a reliable initial project experience to prepare them for subsequent self-directed group work.

Curricula should be related to semesters taking into account the successive increase in the depth and breadth of content and complexity of project work. For each program in each semester specific learning objectives should be formulated incorporating both general educational objectives and specific goals related to the project objectives.

Thus, each program must consist of properly balanced courses of professional orientation, training courses and project courses. In general, the project work of students must include at least 50 percent of their academic credits. Each semester offers a number of project courses related to general education goals and themes of the project. The project courses are taught sequentially within a semester to ensure timely support for project work (i.e. most credits in project courses are held during the first weeks of the semester).

The topics of the problems and project work are consistent with the adopted curriculum. The evolution of the level of students ' problems is allowed as a reflection of their development in the process design work.

If possible, the problems and subsequent project work should reflect the real state of affairs in the profession. It is ensured by a constant interaction between the University and external partners such as businesses, social and government agencies, as well as the awareness of teaching staff in modern scientific developments.

Universities should encourage the students' interaction with external companies and organizations, e.g. through internships.

Students must play an active role in managing basic programs and participate in their analysis and evaluation. Teachers must be involved in the educational model of project - based learning (orientation, training personnel, mentoring, monitoring, etc.), adequately conceive the theoretical basis of the model and be able to apply the best methods of implementing this model.

The University is obliged to provide adequate physical space for student project teams. Each project group should be provided with workstation for the semester. The project team should be provided with all materials necessary to work on projects.

A special procedure should be worked out for students' requesting University funding for expensive supplies or other non-material costs associated with the project (e.g. travel). Funds for these costs are distributed and managed within each program.

Introduction to the project activity

One of the most important organizational principles of project learning within the first year of study has been formulated above. Its essence is that students have to be trained for the project activity. One can consider reducing the introduction period to PL to one semester, but then the proportion of general courses and PL courses will substantially change in favor of the latter.

This paper does not consider theoretical and methodological issues related to project learning. Instead consider the preparation of students to practical work on future projects. We consider it essential that for a semester or two the students got the full idea about the main concepts of the chosen specialty, current problems facing the industry and basic skills to work on standard equipment, which allows them to obtain necessary experimental data. They also should acquire necessary knowledge about safety and initial information about the processing experimental results and their presentation.

Each Department has to work out its program of introduction in PL. For example, in practical part of such a program the Department of Materials Science among the other course will give the sample preparation for metallographic, X-ray, electron microscopic and other studies, mechanical, tribological, etc. tests as well as initial courses of relevant tests. Some courses will undoubtedly be interesting for related departments, such as Casting Production, Welding, Metal Pressure working. In turn, some subjects from introductory Programs of other Departments may be useful for materials science students, e.g. soldering and welding. At the same time, a number of items, such as processing of experimental results, presentation of results and many others can be combined and be delivered to all groups of technical specialties simultaneously, thus saving time and money and allowing the students of different specialties to communicate with each other and get acquainted with the problems of their professions. This process is especially effective if the teachers of respective disciplines illustrate their conclusions with the examples from various fields of technology, familiar to the audience.

Preparing and implementing such introductory courses one can successfully solve the problem of training students for deliberate and real work on professionally-oriented projects. However, judging from many publications the problem remains of rational integration of project activities into the learning process. This problem can be easily solved for graduates and master students and is much more complicated for the bachelors. In case of undergraduates the problem of integration the project work into the mainstream curriculum causes the greatest difficulties. The solution of this problem, maybe apparently found in a more careful selection of projects' topics and certain changes in the organization of the educational process. For example, at MIT the project dealing with the creation and launching a small rocket with telemetric control of parameters is carried out in the second year during several consecutive laboratory works. The greatest assessment in this case obtains the teams which lifted to a maximum height greater load with the lowest expenses. It should be emphasized that this project is implemented within the aerospace majors and students in parallel study the relevant courses.

Organization of project-based learning of part-time students largely depends on the nature of their main job. In case of profile work the theme of the project can often be found directly in the workplace and then evening classes may be used only for consultations.

Conclusions

1. Objectively increasing demands to engineers require a more active implementation of practice-oriented teaching methods.
2. Different versions of practice-oriented methods are known, some of which have long been used in universities. The greatest interest nowadays universities manifest to such varieties of POM as project learning (PL).

3. Incorporation of project learning into everyday practice of higher school brings many additional requirements to all participants of educational process –teachers, students and administration. The greatest difficulties arise in embedding project-based learning in the educational process of bachelors and evening students.
4. The experience acquired by some Russian and foreign universities has shown the expediency of using two first semesters for delivering introductory "project" courses for providing the students a reliable first-hand experience in project work and training them for subsequent self-directed group work.

References

N.G. Khokhlov, Yu.M. Rachkov (2005), "Experience of integrated technical education in European Countries and Russia, Problems of Engineering Education", p. 41-51.

Oelken J. (1991), "Geschichte und Nutzen der Projektmethode / HandbuchProjektunterricht", Weinheim und Basel, Dagmar Hansel (Hrgb) Beltzverlag, 1991.

Aalborg University, "Principles of Problem and Project Based Learning. The Aalborg PBL Model September 2010 Prepared for: Aalborg University Scott Barge from Harvard University.