Application of Learning Outcomes Approach in Education Program Design

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The paper provides methods of education program design based on learning outcome approach. It describes the application of this approach in different countries and suggests the ways of developing modular structure of education programs, projects and interdisciplinary tasks.

Key words: Integrated educational program, learning outcomes, modular structure, evaluation, educational project, standards initiatives CDIO, interdisciplinarity, educational standard.

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The learning outcomes approach is actively used at the universities of Europe, the USA, Canada, Australia and other countries. It is an effective tool for education program designing. The implementation of this approach implies achieving a triune goal: determining the learning outcomes, improving an educational process and developing educational programs appropriate for the target learning outcomes.

The notion "learning outcomes" should not be understood as an antithesis to the term "competence" that was introduced in the Russian Federal State Educational Standards (FSES). They are more likely to be different projections of an activity approach to determining the purpose of an educational process. The key point is the graduate's ability to use effectively skills, knowledge, experience and transferable skills acquired during a course in his/her further professional activity. European scientists often correlate the notion "competence" with a particular person who has this competence and applies it effectively in practice. The term "learning outcomes" is usually associated with an education program.

It should be taken into account that the learning outcomes should conform to the corresponding level of the education program (applied Bachelor Degree course, academic Bachelor Degree program, Master Degree program and Post-Graduate program). The consistency of the program goals with the learning outcomes is set by the Dublin Descriptors and the National qualifications framework.

The learning outcomes are divided into some groups while designing European and international engineering programs.

EUR-ACE Framework Standards for the Accreditation of Engineering Programs [2] has six groups of Program outcomes:

- Knowledge and Understanding;
- Engineering Analysis;
- Engineering Design;
- Investigations;
- Engineering Practice;
- Transferable Skills.

There is UK-SPEC (United Kingdom Standards for Professional Engineering Competence) [3, 206-209] that have four groups of learning outcomes:

- Knowledge and Understanding;
- Intellectual Abilities;
- Practical skills;
- General Transferable skills.

The similar approach is observed in the classification of CDIO Syllabus [4, 22] that classified learning outcomes into four categories:

- Technical knowledge;
- Personal and professional attributes;
- Interpersonal skills;
- Skills specific to the engineering profession.

Benjamin Bloom's Taxonomy, suggested in 1956 [5, 56-59] became a theoretical framework for modern systems of classifying educational goals and objectives. It is a classification system for thinking behaviours that are important in the learning process.

The classification describes an interdependent and consistent way of a learner's cognitive development that includes six increasingly complex levels: Knowledge (information memorizing), Comprehension (understanding), Application (use of knowledge), Analysis (understanding through knowledge decomposition), Synthesis (production of a unique communication), and Evaluation (judgment based on knowledge). To conceive the learning outcomes, that indicate a particular level achievement, a list of action verbs is attached to the classification.

Apart from the cognitive domain which is the most elaborated one, the same approach can be applied to define the learning outcomes in the affective and psychomotor domains.

To prove the fact that Bloom's taxonomy is the base of the learning outcomes classifications existing nowadays, it is possible to give the comparison of Bloom's taxonomy and the learning outcomes classification adopted by Britain Universities:

Learning outcomes categories	Domains of Bloom taxonomy
Knowledge and comprehension	Knowledge, Comprehension (levels of the cognitive domain)
Intellectual Abilities	Application, Analysis, Synthesis, Evaluation(levels of the cognitive domain)
Practical skills	5-7 levels of psychomotor domain
General transferable skills	5 levels of affective domain

While setting learning outcomes the main objective is to define them in a clear and unambiguous way. Learning outcomes are quality indicators of a program or a course that are assessed by colleagues, employers and learners. It should be noted that the learning outcomes set a minimal barrier for the student to have a required number of credits hours or units.

So, the primary task of the education program design is setting learning outcomes for a particular program degree. To work in the CDIO framework it is naturally to use the CDIO Syllabus [6], using so-called the second level of detail in the four determined domains for learning outcomes formulation.

It is necessary to note that the CDIO Syllabus combines the best world experience in developing engineering education programs and allows us to use this experience without "reinventing the wheel". The CDIO Syllabus is compared with a "shopping list" which is very comfortable to make purchases with. At the same time, it is not a ready and unchangeable recipe but a manual for creative users.

As a rule, the number of program learning outcomes is not more than 20. They don't sum up the learning outcomes of the program modules but reflect the integrated knowledge, skills and personal values developed in the course of the whole program.

The setting of program learning outcomes is the most important step in the whole process of a program development. It is the milestone to take into accounts all employers' and educators' interests and join efforts for consistent decision making.

It is quite reasonable at this milestone to use professional standards, if potential employers have such. It is also necessary to take into consideration the prospects of industry development in predicting future needs of the labour market.

In general, the same recommendations can be applied to set the learning outcomes of a program module. But it should be noted that module learning outcomes depend on the program learning outcomes. Though being formulated in different ways they should have a clear conceptual correlation.

As a rule, there are 5-7 learning outcomes defined for each module. The learning outcomes assessment criteria should be clear and consistent not only for the faculty but also for students.

The module learning outcomes should be the result of agreement of all the participants including the learners and the faculty members who develop post/following modules even if these modules are separated in

time.

There is a method to set a combination of separate modules, which is called "black box", i.e. the designers of separate modules (or courses) compare the learning outcomes expected at the input of a module with the learning outcomes received at the output of the pre-requisite modules without peering into the whole structure of the program content. Thus, they achieve the consistency of the modules.

Learning outcomes-program relationship formalization is carried out by developing an operation flow chart of learning outcomes. While designing such a chart it is possible to evaluate the suggested modules by assessing the consistency of their learning outcomes with the program outcomes.

The operation flow chart is a matrix where columns identify the program learning of outcomes and rows refer to the particular program modules. The marks at their crosses identify the connection of a particular module with a particular program learning outcome [7, 34].

As a rule, one module is aimed at achieving some program learning outcomes, whilein its turn one program learning outcome is achieved by a number of modules.

A mutually agreed approach to the formation of the module learning outcomes ensures the most effective performance factor of the modules. That is why, teamwork and mutual understanding of the program designers is an important factor of education program development. We should really "start with ourselves" and show the teamwork competencies that we are going to develop in our students.

The modular structure of an education program does not exclude such things as course, project, internship and other educational activities included in the module. While defining general learning outcomes of a module the designers of particular course syllabi correlate their training plans, change the training content to meet the module requirements. There are cases of more detailed learning outcomes setting with a direct correlation of particular courses (or parts of courses) with particular learning outcomes.

To design a module syllabus is another important milestone in the education program design based on the learning outcome approach. It is developed to ensure coherence of the module learning outcomes with the content of module courses, as well as the assessment tools.

The CDIO concept has a number of standards that determine the distinguishing features of the program developed in the new framework. One of such fundamental standards is standard №3 that is called "Integrated Education Program".

This standard sets quite a difficult task to develop the education program in a way to achieve a number of the Syllabus tasks by combining personal, interpersonal, and system building knowledge and skills that will allow future engineers to produce real products and systems.

The standard recommends that the program should contain these training tasks that when completed would ensure the development of a number of competencies simultaneously, both saving time and improving training quality.

But what is this magic task that boosts the education program so much?

The concept gives a definite answer: this magic tool is educational projects. It is the kind of activities that provides the best opportunities for combining not only knowledge and skills to make engineering products but also for developing personal and interpersonal competencies, such as communicative skills, leadership, teamwork skills, responsibility, engineering ethics, etc.

The common approach to training, when a set of courses is delivered in a definite term, could be transformed into the integrated program that contains these magic tasks and projects. The project work is conducted parallel with the background knowledge acquisition. It starts with some time delay, which allows students to save some "seed capital" that soon will be necessary to fulfill the project tasks. It is this necessity that activates the knowledge and transforms it into a more reliable form – "understanding", which ensures its effective use to solve a project task.

There may be more advanced forms of the training process where the projects are the cornerstones of the educational process. In this case, the knowledge is given as

and when necessary. We are studying these forms, trying to gain foreign experience.

What we really can do at this development stage is to incorporate interdisciplinary project programs into the modules. Thus, the project implementation should require the competencies developed during the courses of the module and the previous modules. It also implies team work, assessment of each student input and supervision and result evaluation made by those teachers involved in the module.

CONCLUSION

The learning outcomes-based approach to the education program design, though appearing simple and obvious, has its "hidden pitfalls". The main risk is a desk-top oriented approach to defining learning outcomes because unconsidered and compiled learning outcomes induce the weakness of the corresponding programs and modules. Another risk is a simplified approach to the learning outcomes setting, that can be caused by the use of simplified tools and criteria and be excused by poor competencies of the students entering the universities. The same results can be achieved by strict adherence to employers' recommendations more resulted from current problems rather than pursuing development prospects. In any case, while developing learning outcomes it is necessary to "raise the bar" and be guided by the highest levels of intellectual development, practical skills and behavior patterns. It's necessary to note that this approach makes us change our attitude to the education program implementation since it gives more active role to students in the educational process by providing them with clear forms of learning outcomes, assessment criteria and active learning techniques. The application of the learning outcomes-based approach will facilitate the process of international accreditation of our programs and ensure real student and staff mobility. Professional standards and reasonable consideration of employers' recommendations should be used as a base for setting learning outcomes. It gives the possibilities for independent accreditation of our programs and, thus, for objective assessment of our work and applicability of the approach.

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