

## E-EVALUATION OF ENGINEERING STUDIES: THEORETICAL OVERVIEW

### INŽENIERSTUDIJU NOVĒRTĒŠANA: TEORĒTISKAIS APSKATS

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**Abstract.** *The paradigm shift from input to output based engineering education, on the one hand, and digitalization of engineering education, on the other hand, have influenced the enhancement of such area of engineering studies as e-evaluation. However, e-evaluation of engineering studies has attracted little attention. The aim of the contribution is to analyze theoretical literature on e-evaluation of engineering studies underpinning elaboration of a research question on use of information technologies such as multimedia technologies, information systems, etc for e-evaluation of engineering studies. The meaning of the key concepts of assessment, evaluation and e-evaluation is studied. Moreover, the study shows how the steps of the process are related: theoretical overview of e-evaluation of engineering studies → elaboration of a research question on use of information technologies for e-evaluation of engineering studies → conclusions. The novelty of the present contribution is formulated in the research question on use of information technologies for e-evaluation of engineering studies. Directions of further research are proposed.*

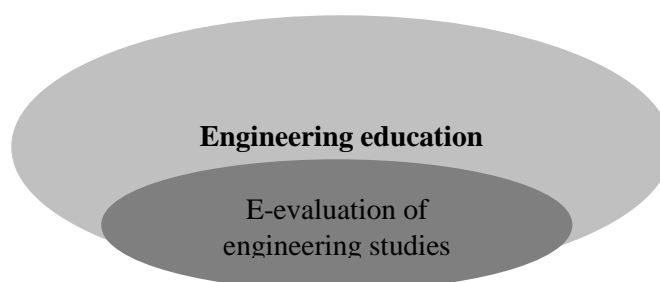
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**Keywords:** *conditional thickness method, influence factor, mining block, pillar, roof, stability.*

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### Introduction

The paradigm shift from input to output based education in general and engineering education in particular, on the one hand, and digitalization of education in general and engineering education in particular, on the other hand, have influenced the enhancement of such area of engineering studies as e-evaluation as depicted in Figure 1.



**Fig. 1: The relationship between engineering education and e-evaluation of engineering studies**

The changes in engineering education are of bi-modal nature as the changes obtain two contrasting modes or forms [2]: on the one hand, there is a transformation from assessment of teaching to evaluation of engineering studies, and, on the other hand, there is a shift from evaluation of engineering studies to e-evaluation of engineering studies.

However, e-evaluation of engineering studies has attracted little attention in research as most of the efforts were devoted to the elaboration of e-assessment system for skill and knowledge assessment in computer engineering education [5].

The aim of the present contribution is to analyze theoretical literature on e-evaluation of engineering studies underpinning elaboration of a research question on use of information technologies such as multimedia technologies, information systems, etc for e-evaluation of engineering studies.

The novelty of the present contribution is formulated in the research question on use of information technologies for e-evaluation of engineering studies.

### Materials and methods

The meaning of the key concepts of assessment, evaluation and e-evaluation is studied. Moreover, the study shows how the steps of the process are related: theoretical overview of e-evaluation of engineering studies → elaboration of a research question on use of information technologies for e-evaluation of engineering studies → conclusions.

The methodological foundation of the present research is formed by the System-Constructivist Theory. The System-Constructivist Theory and, consequently, System-Constructivist Approach to learning introduced by Reich [10] emphasizes that human being's point of view depends on the subjective aspect [7]: experience plays the central role in the knowledge construction process [7]. Therein, the subjective aspect of human being's point of view is applicable to the present research.

Exploratory research was employed in the empirical study [9]. Exploratory research is aimed at generating new questions and hypothesis [9]. The exploratory methodology proceeds as shown in Figure 2

- from exploration in Phase 1
- through analysis in Phase 2
- to hypothesis development in Phase 3.
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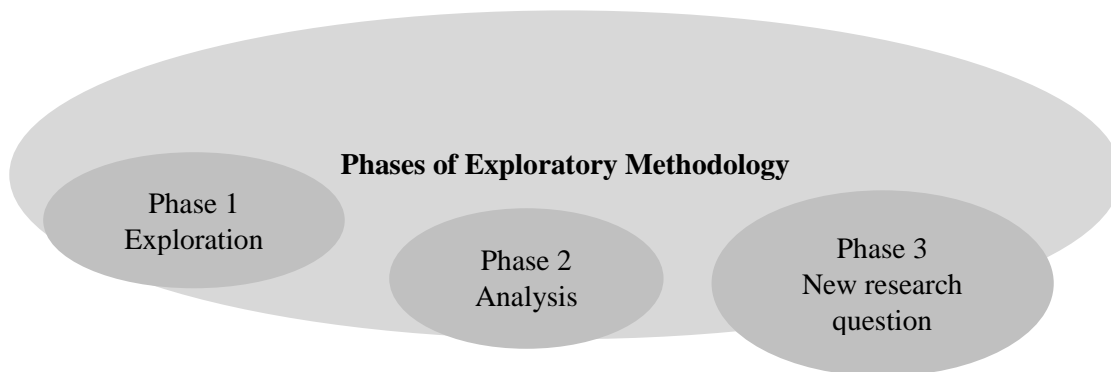
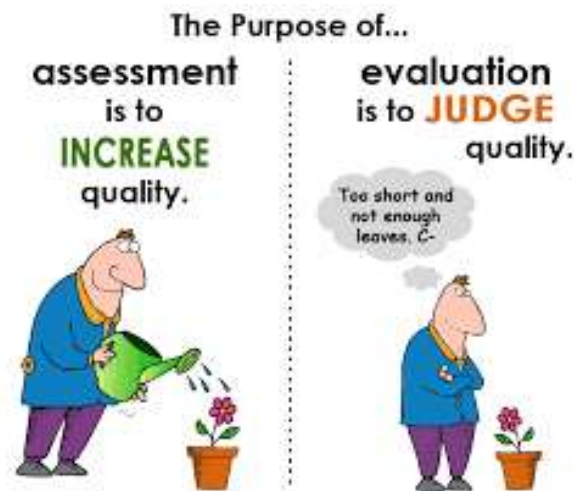


Fig. 2. Methodology of the exploratory research

The interpretive paradigm was used in the empirical study. The interpretive paradigm aims to understand other cultures, from the inside through the use of ethnographic methods such as informal interviewing and participant observation, and establishment of ethically sound relationships [11]. The core of this paradigm is human experience, people's mutual everyday interaction that tends to understand the subjectivity of human experience [6]. The paradigm is aimed at understanding people's activity, how a certain activity is exposed in a certain environment, time, conditions, i.e., how it is exposed in a certain socio-cultural context [6]. Thus, the interpretative paradigm is oriented towards one's conscious activity, and it is future-oriented [6]. Interpretative paradigm is characterized by the researcher's practical interest in the research question [3]. The researcher is the interpreter.

## Results

On the one hand, Figure 3 [13] points out the difference between the terms “evaluation” and “assessment”.



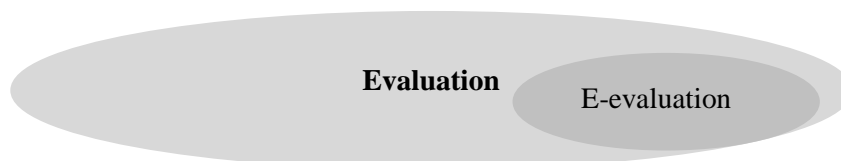
**Fig.3. Difference between the Terms “Evaluation” and “Assessment” (adapted from [13])**

On the other hand, Figure 4 [1] demonstrates that evaluation includes assessment [4].



**Fig. 4. Inter-connections between evaluation and assessment**

Traditionally, assessment reveals student advancement, placement and grades [1]. In its turn, evaluation provides feedback on the worth or value of a course, module or curriculum. Moreover, evaluations often utilize assessment data along with other resources to make decisions about revising, adopting, or rejecting a course, module or curriculum [1]. By evaluation, the process of examination and its results is determined [1]. Evaluation provides feedback on the worth or value of a course, module, curriculum and interaction among evaluators [6]. Evaluation is defined as evaluation with the focus not on evaluation of learning results but with the focus on evaluation of inter-connections between learning and its results in the united system of criteria [4,8]. Finally, e-evaluation is considered to be computer-mediated process of examination and its results. The term “evaluation” is further used as an overall umbrella for both evaluation and e-evaluation as e-evaluation is part of evaluation.



**Fig. 5. The relationship between evaluation and e-evaluation**

The process of evaluation includes such five phases [6] as preparation of evaluation plan, goal identification, aim of practice change, justification of the criteria and evaluation and presentation of practice changes. Goal of evaluation can vary [4] from diagnostic evaluation in Phase 1 through formative evaluation in Phase 2 to summative evaluation in Phase 3 as depicted in Figure 6. Diagnostic evaluation is carried out at the course beginning to obtain information on the learners' knowledge and skills [4]. Then, formative evaluation is organized in the middle of the course to check the learners' gradual educational progress [4]. And, finally, summative evaluation at the course end reveals the learners' aim achievements and transfer to the next (a higher) educational level [4].

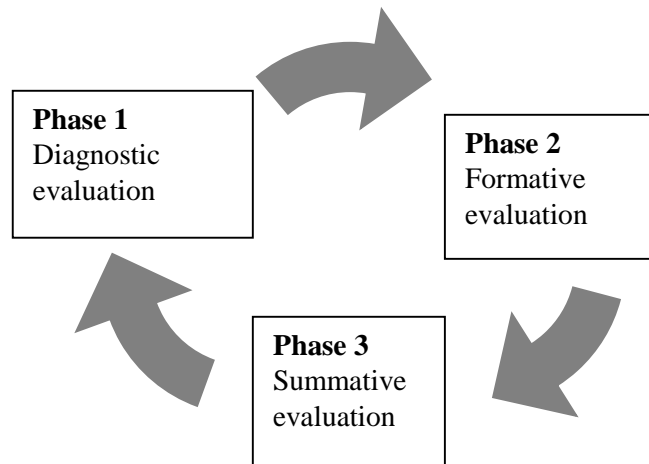


Fig. 6: Goal of evaluation

Evaluation comprises such elements as external evaluation, internal evaluation and self-evaluation. Self-evaluation is defined as the learners' process to think, analyze and plan their learning in accordance with criteria worked out together with the educator that results in a report called *self-evaluation* in a written form [4]. Internal evaluation is determined as the process of the teacher's and learners' evaluation of the learner's work in accordance with the joint criteria as well as the learners' and management's of the educational establishment evaluation of the teacher's work that results in a report called *internal evaluation* in a written form [4]. External evaluation is identified as the process of external experts' evaluation of the work of the teachers, learners and management of the educational establishment in accordance with certain criteria that results in a report called *external evaluation* in a written form [4]. Evaluation proceeds from self-evaluation through internal evaluation to external evaluation as revealed in Figure 7.

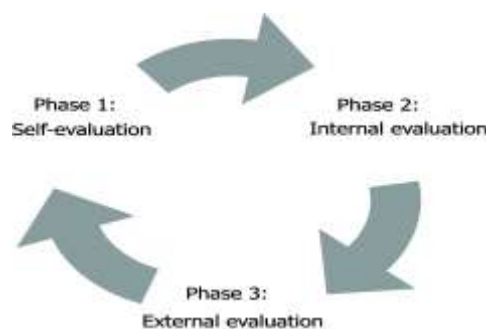


Fig. 7. Methodology of evaluation

Various methods and instruments may be used for gathering the information needed for evaluation such as [12]

- Questionnaires: list of questions to be asked to respondents;
- Observations: evaluation data may be gathered by observing the behaviour of the participants e.g. teachers, students, others. Identify carefully which behavioural traits should be observed and what meanings can be deduced from these;
  - Interviews: oral questionnaire, either structured semi-structured or open. Interviews may be held individually or with groups;
  - Meetings: meetings stimulate people to reflect on things and to discuss them. While doing so evaluation implicitly occurs;
  - Snowballing/Delphi: people may be asked individually what they think of particular things, but it is certainly illuminating for them to hear or read what the same things meant for others. By making a list of the issues raised, or of opinions given, the opportunity is created for others to comment. In this way an overview is created of possible opinions and the support for each of them;
  - Written product: writing about one's experiences is a powerful way of reflecting;
  - Presentations: telling others what happens in your school or in your project forces you to reflect on this as well. This is also occurs with the critical questions which may be raised by your audience. Again this method can prove to be a powerful stimulator for learning from experiences;
  - Flowcharting: by describing the process of a course or training session using a "flowchart" diagram, it will be possible to reflect not only on the different stages of the process but also on the link between the different stages;
  - Critique/reviews: by internal or external experts/colleagues. Inviting others to come and give their views on what they perceive to be happening in a project, at the school or in a programme is a positive way of triggering an internal debate about quality;
  - Unobtrusive measures: some data may be gathered without requiring assistance from other people. How often do students visit the library? How many parents come to meetings or answer correspondence? Recording secondary information such as the speed at which the chairs in the study room deteriorate will determine the intensity with which the room is used.
  - Reports/minutes: Some documents are produced even if no evaluation takes place. Nevertheless they may have a function in an evaluation and support the reflective process that evaluation should trigger. Furthermore the data in these documents may be considered as material for further analysis.

As evaluation techniques include a range of forms which can be also blended [13], learner's assesment may include [13] such forms as (E-) Checklist (observation), (E-) Behavior description (observation, self), (E-) Attitude scale, (E-) Conversation, (E-) Portfolio, (E-) Case, (E-) Report, (E-) Paper, (E-) Simulation, (E-) Presentation, (E-) Competence based interview, Internship, etc. Other instruments valid for evaluation [12] such as

- Thermometer plus immediate feedback: a kind of thermometer is drawn on a flipchart to indicate how participants value the event in which they take part. The flip chart is turned away from the group, and then one by one they pass by the flipchart and mark their position on the line of the "thermometer" with a board pen. You can choose whether you want to identify the dimension on which they score, or leave that open. Afterwards you turn around the flipchart so that the distribution of positions on the line drawn is visible to everybody. This may then be discussed and clarified.
- Letter addressed to yourself: ask people to write a letter to themselves including statements of what they have learned or what they intend to go and do with what they have learned. Then send these letters to the people involved after a certain period. It improves both their learning and the impact of the evaluation.

- Writing an article about the project/programme: nothing is more evaluative than to have to present the experience on paper. This requires analysis, comparisons, reflections, formulation, and articulation;
- Presentation: the advantage of a presentation compared to an article is of course the discussion it triggers. The dialogue that follows is one of the richest ways of learning from experience;
- Contribution to a school or academic journal, a newsletter: this serves a similar purpose, but now the negotiation element of evaluation comes into focus. It not only triggers a discussion aimed at understanding, but also one aimed at interests, division of power, responsibility, authority etc;
- Creating a web site about the project/programme: the use of new technologies adds to the quality of this instrument. Furthermore it serves a similar purpose as writing articles or making a newsletter;
- Self-reflection instruments: there are instruments available which help to reflect on particular aspects of your learning, educating, training, organisation etc. Issues covered by such instruments could be the school climate, the quality of a learning environment/team spirit/ effectiveness/ leadership etc. After an experiment with new methods, an instrument might be used to see what effect this new approach has on how the school is perceived or what the effects have been on the learning environment;
- Sparring partner/critical friend: having someone to talk to, to have debates with, to share doubts with, to share your professional kicks with, enriches the learning process enormously. As made clear elsewhere in this document, there must then be a moment when the result of this learning is made explicit and transferable;
- Working with scenarios: one aspect of learning is the ability to do things better in future. Developing future scenarios immediately turns present experiences into options for the future. This facilitates the transfer of what is learned, to future actions, or decisions about the future. It is desirable to develop two or three scenarios rather than one, in order to promote/trigger the dialogue that is needed to provide the rich learning context which makes self-evaluation a learning experience;
- Critical incidents method: reconstruct events from your experience and identify critical moments where you had to make major decisions. Ask others to think about what they would have done in this situation. Describe your choice and compare it with the choices others have made. Identify what it implies for future action;
- Reflective silence STAR (Situation, Time, Actions, Results): it sometimes is very useful to build in silences in the rush-rush, hectic race of daily professional life. Use these moments to reflect and write down what you wish to remember from the experiences you have been through. Consider alternative actions and reflect again on them;
- Learning questions related to personal development plans: most organisations do not have the habit of allowing or encouraging their staff to identify learning questions. If teachers, trainers, managers and others concerned know what they want to learn, they focus much better on the relevant experiences in their work and make progress. Often the learning goals and objectives of the professionals are left vague and ambiguous. This is counterproductive for effective learning and as a consequence for the organisation's quality and its ability to change;
- 360° feedback: this is a deliberate confrontation of observations and views of a professional with the observations or views of superiors, colleagues, subordinate staff or students. The focus is on the different perspectives to which the differences in position might lead, in order to understand better the dynamics of the world in which one operates;
- Visualising things either graphically or more creatively: the power of images is often greater than that of words. However, this is rarely used in evaluation. Try to visualise



things and make them visible, or tangible, or heard in a creative way. This will certainly create a much greater impact;

- Debate, an adversarial evaluation procedure comparable with a trial process in court with a jury: this method, which is very stimulating and which creates high commitment, emphasises the negotiation part of evaluation. At the same time it stimulates the motivation to learn. It may be a time-consuming approach, but it certainly makes evaluation come to life;

- Allocating money as a token of the priorities given to different parts of the project: dividing money clearly shows the values given to various aspect of schooling. It is a way to operationalise the value given to things. People tend to be willing to fight really hard about money. The fight over money makes it clear where people put their priorities, the debate about why and about the evidence that is what it is all about. This is what provides the learning and the clarification of the positions of all parties involved in the school;

- Serving as a consultant in other similar projects: actively helping others in evaluation is often a very good way to analyse your own situation. Because others want to know what your advice is, you will have to be very explicit about what you think may work out, and what you think won't. Questions will be asked about evidence and the background of your advice. Thus you will have to make up your own mind systematically.

Other forms of learners' satisfaction assessment may include distance education orientations, learner profile study, learner satisfaction survey, learner evaluation of effectiveness of distance education. In its turn, staff support assessment can be done via faculty/department/staff satisfaction survey, review of academic credentials for new hires, needs analyses for staff training. Evaluation of teachers can be carried out via learner academic and professional success, too. Assessment of programme effectiveness can be based on the following questions:

- What do you wish to do?(*Vision*);
- What steps should be taken to get there?(*Goals*);
- What do you need to achieve for each step?(*Objectives and Outcomes*);
- How well are you doing it? (*Measures*);
- What and how does a program contribute to the development and growth of its learners?

Learner Learning and Course Assessment Techniques include review of learning resources, course evaluations, classroom inventory, course development review. Such an evaluation form as accreditation comprises the following dimensions: institutional context and commitment, curriculum and instruction, student support, evaluation and assessment. Evaluation of distance education materials is based on the analysis of instructional design, content, textbook, department guide, learner study guide, computer software, computer conferencing software, video, etc. Evaluation can also involve grouped observations of administration, course preparation and instructional design, communication techniques, test instruments and continuous assessment, training of staff. Such e-tools can be integrated into evaluation as monkey survey, webinars, use of the Moodle platform, blogs, use of social media, etc.

### **Results and discussion**

The theoretical findings of the present research allow drawing the conclusion on e-evaluation as part of evaluation.

The theoretical findings outlined the notion of e-evaluation, its methodology, methods and instruments as well as techniques presented in the contribution.

The following research question has been formulated: What principles are to use of information technologies such as multimedia technologies, information systems, etc for e-evaluation of engineering studies? It should be noted that principle is a condition of activity

(Beļickis, Blūma, Koķe, Markus, Skujiņa, Šalme, 2000) or, in other words, use of information technologies in the present contribution.

The present research has *limitations*. The inter-connections between assessment, evaluation and e-evaluation have been set. Another limitation is the theoretical study conducted by involving the educational researchers only.

Further research tends to involve computer scientists in the present research on e-evaluation of engineering studies. Empirical studies on use of information technologies such as multimedia technologies, information systems, etc for e-evaluation of engineering studies are to be carried out. The search for relevant methods for e-evaluation of the use of information technologies such as multimedia technologies, information systems, etc for e-evaluation of engineering studies is proposed. And a comparative research of different countries could be carried out, too.

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