# CLUSTERING IN ENGINEERING EDUCATION IN THE BALTIC REGION

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**Abstract**: *The contemporary situation in the Baltic region, namely, the lack of working places due to the structural problems, a high unemployment rate, the migration of highly qualified people and the low rate of self-employees, demands on innovation as an engine of the economic development with a strong impact on sustainable development in the European Union. Clusters became a target for local and regional initiatives to promote competitiveness and job-creation. Cluster contributes to new and better jobs in new industries and offers potential solutions for the quality, maintenance and sustainable development of the economy in the European Union. Cluster is formed by the collaborative process based on mutual sustainability, complementarity and reflexivity. University in a cluster provides student engineers with the appropriate skills and competences for innovation and creates new knowledge within the "knowledge triangle" of education, research and innovation. The hypothesis for further studies is put forth.*

**Keywords:** C*lustering, Engineering Education, the Baltic Region*

## 1. INTRODUCTION

The contemporary situation in the Baltic region, namely, the lack of working places due to the structural problems, a high unemployment rate, the migration of highly qualified young people and the low rate of self-employees (Bassus, Wolfgramm, 2009, p. 36), demands on innovation as an engine of the economic development with a strong impact on sustainable development. Moreover, the change in engineer entering the service area, namely, not working permanently at a large-scale enterprise but accepting project-related orders of large-scale enterprises by free engineers' office (Bassus, Wolfgramm, 2009, p. 38) emphasizes the necessity in innovation-stimulating environments (Meyer-Stamer, 2000, p. 2) in the Baltic region.

The development of innovative products, processes and services in the European economy is advanced by a geographic concentration of the synergy between interconnected businesses, suppliers, service providers, and associated institutions in a particular field known as a regional industry cluster (Mills, Reynolds, Reamer, 2008, p. 6). In the course of the 1990s, *clusters* became a target for local and regional initiatives to promote competitiveness and job-creation (Meyer-Stamer, 2000, p. 1). Clusters were expected to stimulate the innovativeness and competitiveness of companies, especially small and medium-sized enterprises (Meyer-Stamer, 2000, p. 2). Therein, enterprises are a basis for prosperity and economic development. University as part of a cluster provides student engineers with the appropriate skills and competences for innovation and creates new knowledge within the "knowledge triangle" of education, research and innovation.

The inter-relationship between innovation and university education, namely, innovation as a driver of education and University education as the mainspring of the human factor in innovation (Lapiņa, 2008), requires clustering in engineering education to be considered.

The analysis of clustering in engineering education on the pedagogical discourse involves a process of analyzing the meaning of the key concepts "cluster" and "collaboration". Moreover, the study demonstrates how the key concepts are related to the idea of "engineering education".

The study presents how the steps of the process are related: defining clustering → revealing collaboration → empirical study in a multicultural environment within engineering education.
The methodological foundation of the present research on the analysis of clustering in engineering education is formed by the System-Constructivist Theory based on Parsons's system theory (Parsons, 1976) on any activity as a system, Luhmann's theory (Luhmann, 1988) on communication as a system, the theory of symbolic interactionalism (Mead, 1973) and the theory of subjectivism (Groeben, 1986). The System-Constructivist Theory emphasizes that human being's point of view depends on the subjective aspect (Maslo, 2007. p. 39):

- everyone has his/her own system of external and internal perspectives that is a complex open system (Ahrens, Zaščerinska, 2010, p. 180), and
- experience plays the central role in a construction process (Maslo, 2007, p. 39).

Therein, the subjective aspect of human being's point of view is applicable to the present research to analyze clustering in engineering education.
The remaining part of this paper is structured as follow: Section 2 introduces the theoretical framework of clustering in engineering education. The associated results of an empirical study will be presented in Section 3. Finally, some concluding remarks are provided in Section 4 followed by a short outlook on interesting topics for further work.

## 2. THEORETICAL FRAMEWORK

The theoretical framework of the present contribution involves the meaning of the key concepts of "clustering" and "collaboration" to be studied.

### 2.1 Defining clustering

The concept of *cluster* is not static. The *cluster* concept changes in time. First, cluster in education was the concept of a number of neighbouring school districts working together for the benefit of all. The potential benefits were greater when such working relationships took place in close co-operation with institutions of higher education, intermediate service agencies and the state education agency (Nahtigal, 1985, p. 4). A cluster was formed in four essential steps, namely,

- first, the group of interested schools must be identified,
- second, the identification of individuals within a neighbouring institution of higher education that have the interest, technical assistance skills and commitment to work with a cluster over time,
- third, the establishment of contact with key persons in the state education agency to work with the cluster,
- the final step is the development of an agenda to be addressed by the cluster which must be that of the participating districts, not that of the institution of higher education or the state educational agency.

Then, the emphasis was put on regional industry clusters, namely, geographic concentrations of interconnected firms and supporting organizations in a particular field, which represent a potent source of productivity at a moment of national vulnerability to global economic competition (Mills, Reynolds, Reamer, 2008, p. 3). Finally, a university is part of a cluster that involves educational and research institutions, enterprises and other interested organizations as depicted in Figure 1.

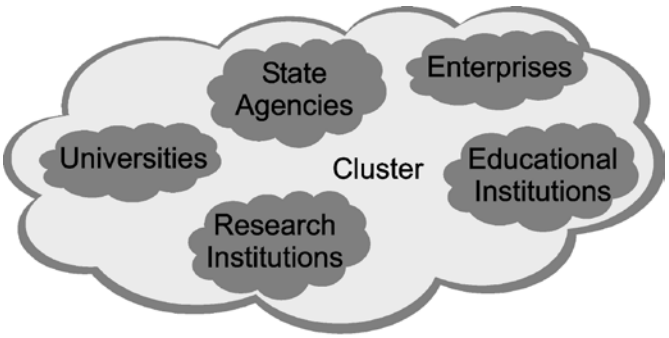


*Figure 1*: Components of a cluster
*1. attēls*: Klastera komponenti

Clustering is not provided by co-operation inside a cluster as the relationship between firms, between firms and institutions, and between the private and the public sector that is weak, in particular when it comes to activities that go beyond common business transactions. Collaboration forms strong relationships inside clusters (Meyer-Stamer, 2000, p. 2).

### 2.2 Clustering in Engineering Education

Clustering is formed by collaboration. Collaboration is product orientated. Product on the pedagogical discourse is defined as experience. Experience is the unity of knowledge, skills and attitudes gained during life, evaluated positively by the individual, strengthened in his/her habits and used in a variety of activities in different situations. Collaboration is a coordinated, synchronous activity that is the result of a continued attempt to construct and maintain a shared conception of a problem (Roschelle, Teasley, 1995). The present research proposes the pedagogical process to be a form of collaboration. Hence, the collaborative process for forming clusters is based on the system of key principles, principles and regulations as shown in Table 1. However, collaboration is formed by factors.

*Table 1*: The system of key principles, principles and regulations of collaboration
1. tabula: Sadarbības atslēgprincipu, principu un noteikumu sistēma

<table>
<tr><th colspan="3">Key Principles</th><th>Principles</th><th>Regulations</th></tr>
<tr><td rowspan="5">Mutual Sustainability</td><td rowspan="5">Mutual Complementarity</td><td rowspan="5">Mutual Reflexivity</td><td>Professional environment</td><td>Opportunities for the individual’s development and professional development</td></tr>
<tr><td rowspan="2">Mutual complementarity</td><td>Analysis of problem situation</td></tr>
<tr><td>Mutual exchange, mutual contradiction solving, mutual decision making, etc.</td></tr>
<tr><td>Social and academic readiness</td><td>Opportunities to construct social experience (experience of social interaction and cognitive activity); acquiring academic knowledge and skills, etc.</td></tr>
<tr><td>Mutual reflexivity</td><td>Reflection, mutual feedback</td></tr>
<tr><td colspan="5">Developing the system of the external and internal perspectives</td></tr>
</table>

#### 2.2.1 Defining Factors

Factor is defined as a reason of the research subject change (Lasmanis, 2008). Factors are considered to be as external and internal (Lasmanis, 1997).

- External factors in pedagogy are determined as surroundings and resources.
- Internal factors in pedagogy include the aims of the student’s activity, motivation, interest, skills and experience.

Thus, factors form collaboration to enable the synergy between the cluster’s institutions.

### 2.2.2 Factors Forming Collaboration

The analysis of external and internal factors in pedagogy as well as the definition of collaboration allows considering the following factors and their components (Zaščerinska, Ahrens, Bassus, 2009, pp. 214-216), namely, factors forming communication, teacher's purposeful activity as an external factor (Žogla, 2008) and learning factors.

Factors forming communication are aural medium, socio-cultural factors and non-verbal communication system (Shumin, 1997, p. 8).

In order to organize teaching activity, teacher prepares materials including specifically chosen lexical areas carefully and seeks repetition of information (Kramiņa, 2000, p. 75). Then, teacher clarifies the task carefully before undertaking it, plans whether the activity should fit into the general progression of the syllabus or whether it should be an independent activity aimed at satisfying the study purpose of certain individual learners. As well as teacher finds out whether the activity fits in with other and parallel teaching situations, negotiating a balance between task needs and individual or group needs, planning how varied the types of activities should be. Moreover, competition is considered by teacher as a stimulus and not as a hostile activity. Besides, teacher's scoring the activity results should help the learners to be aware of their progress. Finally, teacher should ensure sensitivity to any emotional or cultural blockages which might interfere with the learners' confidence to use the knowledge in relation to the particular topic, situation or functional purpose (Kramiņa, 2000, p. 75). Thus, the teacher is identified in a number of roles that relate to the process of organizing teaching activity (Hedge, 2000, p. 26): assessor, corrector, organizer in giving instructions for the pair work, e.g., initiating it, monitoring it, and organizing feedback, prompter while students are working together and resource if students need help.

Finally, there is a range of learning factors. Learning achievements depend on (Shumin, 1997, p. 8) the age of students, affective factors, namely, emotions, self-esteem, empathy, anxiety, attitude, motivation, and learning experience.

## 3. EMPIRICAL RESEARCH

The research design within the present research comprises the research methodology, the sample of the present research and the research findings considered.

### 3.1. Research Methodology

This study is oriented towards the revealing of effectiveness of the collaborative process within the cluster of the Baltic Summer School 2010 as highlighted in Figure 2 to improve the learners' competences and learning outcomes in use of Enterprise 3.0.

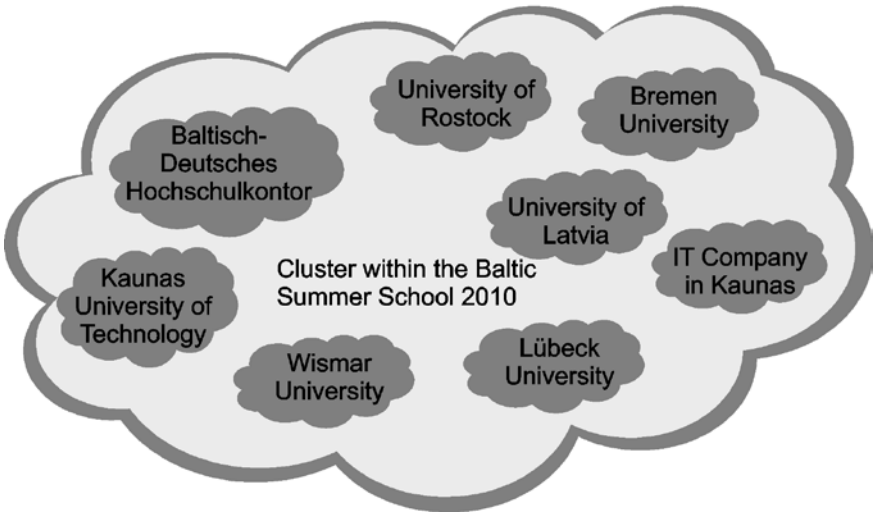

Figure 2: Cluter of the Baltic Summer School 2010 in Kaunas, Lithuania
2. attēls: Baltijas Vasaras skolas klasteris Kauņā Lietuvā 2010. gadā

Its topicality is determined by ever-increasing flow of information in which an important role is laid to Enterprise 3.0 as a means of getting information and gaining experience. The collaborative process within the cluster of the Baltic Summer School 2010 involved visiting an IT company in Kaunas, courses in technical informatics and information technology (German and English), preconference tutorials for introduction into advanced research topics, participation in the conference "Learning in Networks", tutorials and practical tasks, language training for talk and presentation (optional in English or German) and leisure activities and social contacts. The collaborative process within the cluster of the Baltic Summer School 2010 was implemented from teaching in Phase 1 to learning in Phase 3 through peer-learning in Phase 2 as depicted in Figure 3 (Zaščerinska, Ahrens, 2010, p. 184).

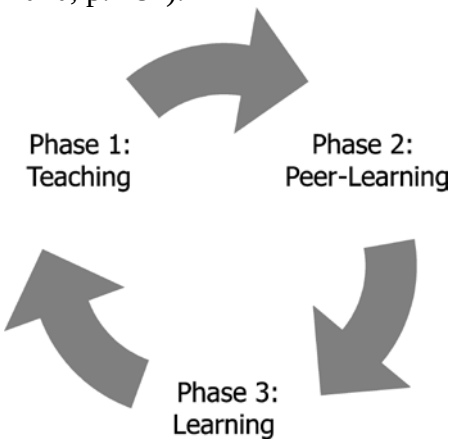


Figure 3: Phases of the pedagogical process
3. attēls: pedagoģiskā procesa fāzes

Students' use of Enterprise 3.0 was promoted by a variety of teaching techniques with use of Enterprise 3.0, namely, discussion, prepared talk, communication games and information-gap activities in the collaborative process within the cluster of the Baltic Summer School 2010.

An explorative research aimed at developing hypotheses, which can be tested for generality in following studies (Mayring, 2007) has been used in the research. Interpretative research paradigm which corresponds to the nature of humanistic pedagogy has been determined for the research as it creates an environment for the development of any individual and helps them to develop their potential (Lūka, 2008). The study consisted of the following stages: exploration of the context of use of Enterprise 3.0 through thorough analysis of the documents, analysis of the students' feedback regarding their needs in use of Enterprise 3.0, data processing, analysis and data interpretation, analysis of the results and elaboration of conclusions and hypothesis for further studies.

Analysis of the students' feedback regarding their needs in Enterprise 3.0 was based on the following questionnaire: Question 1: Do you know the concept of Enterprise 3.0? Question 2: Do you use Enterprise 3.0 for your individual purposes? Question 3: Do you use Enterprise 3.0 for your organizational purposes? Question 4: Do you use Enterprise 3.0 for your professional purposes? Question 5: Do you participate in activities for your professional development, namely, education, in-service training and/or learning, in use of Enterprise 3.0?

The evaluation scale of five levels for each question is given where "1" means "disagree" and low level of experience in use of Enterprise 3.0 technologies and "5" points out "agree" and high level of use of Enterprise 3.0 technologies. It should be mentioned that the emphasis of the System-Constructivist Theory on the subjective aspect of human being's point of view and experience that plays the central role in a knowledge construction process does not allow analyzing students' needs in Enterprise 3.0 objectively: human beings do not always realize their experience and their wants in use of Enterprise 3.0.

The descriptive statistics (*Mean* and *Standard Deviation*) in the SPSS 17.0 software for primary quantitative data analysis were used. Data validity is examined by the method triangulation and data triangulation.

### 3.2. Respondents of the Research

The present empirical study conducted during the implementation of Sixth Baltic Summer School *Technical Informatics and Information Technology* at Kaunas Technical University, August 13-28, 2010, Kaunas, Lithuania involves the sample of 28 participants.

All 28 participants of Sixth Baltic Summer School *Technical Informatics and Information Technology* have got Bachelor or Master Degree in different fields of Computer Sciences and working experience in different fields. The International Summer School offers special courses to support the internationalization of education and cooperation among the universities of the Baltic Sea Region. The aims of the Baltic Summer School are determined as preparation for international Master and Ph.D. programs in Germany, further specialization in computer science and information technology and learning in a simulated environment. Baltic Summer School *Technical Informatics and Information Technology* does not contain a special module on Enterprise 3.0. The Summer School *Technical Informatics and Information Technology* contains a special module on Web 2.0. The Web 2.0 module examines the advantages and problems of this technology, namely, architecture and management, protocol design, and programming, which makes new social communication forms possible. The Web 2.0 module does not reveal the concept of Enterprise 3.0. However, the Web 2.0 module comprises Enterprise 3.0 technologies, namely, online networks. The Web 2.0 module involves Ajax (Asynchronous JavaScript and XML) and Advanced Javascript Programming Libraries, Security for Web Portals, Web 2.0 Design Paradigms, Patterns for Rapid Web Prototyping and Ruby on Rails.

The 28 participants of Sixth Baltic Summer School *Technical Informatics and Information Technology* are with different cultural backgrounds and diverse educational approaches from different countries, namely, Latvia, Lithuania, Estonia, Russia, Great Britain, China, India, Nigeria, Romanian and Mexico. Whereas cultural similarity aids mutual understanding between people (Robbins, 2007), the students' different cultural and educational backgrounds contribute to successful learning and become an instrument of bringing the students together more closely under certain conditions, namely, appropriate materials, teaching/learning methods and forms, motivation and friendly positioning of the educator (Abasheva, 2010). Moreover, the sample of the participants of the Sixth Baltic Summer is multicultural.

### 3.3. Findings of the Research

Between the pre- and post-survey of the participants' use of Enterprise 3.0 the collaborative process with use of Enterprise 3.0 technologies, namely, online networks, was implemented within the cluster of Sixth Baltic Summer School *Technical Informatics and Information Technology*.

After having implemented the collaborative process with use of online networks of Enterprise 3.0 technologies, the results of two surveys of the participants' experience in use of Enterprise 3.0 within the Sixth Baltic Summer School 2010 demonstrate the positive changes in comparison with the pre-survey. The *Mean* results of the descriptive statistics as highlighted in Table 1 demonstrate that the level of the students' use of Enterprise 3.0 has increased in the post-survey (3,28) in comparison with the pre-survey (1,68).

Table 1: Mean analysis of the pre- and post-surveys carried out with the participants of the Baltic Summer School 2010

| Question | Pre-Survey | Post-Survey |
|---|---|---|
| 1 | 1,86 | 3,25 |
| 2 | 1,75 | 3,44 |
| 3 | 1,54 | 3,33 |
| 4 | 1,57 | 3,16 |
| 5 | 1,68 | 3,21 |
| mean | 1,68 | 3,28 |

The surveys of the students' feedback regarding their needs in Enterprise 3.0, as emphasized in Table 1, reveals that the students do not realize the possibilities offered by Enterprise 3.0 properly.

The comparison of the *Standard Deviation* (Std. Deviation) results as shown in Table 2 reveals that the scores of the post-survey are spread wider than the scores in the pre-survey.

Table 2: Standard Deviation analysis of the pre- and post-surveys carried out with the participants of the Baltic Summer School 2010

| Question | Pre-Survey | Post-Survey |
|---|---|---|
| 1 | 1,85 | 2,35 |
| 2 | 1,14 | 2,40 |
| 3 | 1,99 | 2,39 |
| 4 | 1,57 | 2,19 |
| 5 | 1,96 | 2,31 |
| mean | 1,70 | 2,33 |

Hence, the results of *Mean* and *Standard Deviation* within the surveys of the students' feedback regarding their needs in Enterprise 3.0 reveal that most of answers are concentrated around Level 2 and 3. Thus, there is a possibility to increase the students' use of Enterprise 3.0 within Web technologies.

## 4. CONCLUSIONS

The empirical results reveal that the collaborative process with use of Enterprise 3.0 within the cluster of Sixth Baltic Summer School *Technical Informatics and Information Technology* is effective to contribute to the students' competences and learning outcomes in use of Enterprise 3.0.

The present research has *limitations*. Use of Enterprise 3.0 in the Sixth Baltic Summer School was studied paying attention to the students' feedback regarding their needs, but it was studied in isolation from the evaluation of educators. Another limitation is the length of the research. If the results of other Baltic Summer Schools had been available for analysis, different results could have been attained. There is a possibility to continue the study.

The following hypothesis for further studies is put forth: in order to increase the student engineers' competences and learning outcomes in use of Enterprise 3.0 in engineering education it is necessary to promote student engineers' participation in the engineering cluster which provides a favourable learning environment, supports learners' needs and organizes successful use of Enterprise 3.0 in engineering education.

## Kopsavilkums

Mūsdienu situācijai Baltijas reģionā, proti, nepietiekamais darba vietu skaits sakarā ar strukturālo reorganizāciju, augsts bezdarba līmenis, augsti kvalificēto cilvēku imigrācija un pašnodarbinatība zemā līmenī, ir nepieciešamas inovācijas kā dzinējspēks ekonomikas attīstībā situacijas uzlabošanai Eiropas Savienības ilgtspējīgā attīstībā. Klasteris kļuva par vietējo un reģionālo iniciatīvu mērķi, lai veicinātu konkurētspēju un radītu jaunas darba vietas. Universitāte kā klastera daļa nodrošina studentus ar atbilstošām prasmēm un kompetencēm inovāciju un jauno zināšanu radīšanai "zināšanu trīsstūrī", proti, izglītībā, pētniecībā un inovācijā. Klasteris tiek veidots sadarbībā pedagoģiskajā procesā, kurā pamats ir savstarpēja ilgtspējībā, komplementaritātē un refleksivitātē, kas sekmē jaunu un labāku darbavietu veidošanu jaunas nozarēs un piedāvā iespējamos risinājumus ilgtspējīgas ekonomikas attīstībā Eiropas Savienībā.

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