CLUSTERING FOR THE DEVELOPMENT OF ENGINEERING STUDENTS' USE OF ENTERPRISE 3.0

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ABSTRACT

Enterprise 3.0 which penetrates our society more thoroughly with the availability of broadband services has already been widely integrated into the contemporary processes and work environments. The synergy between Enterprise 3.0 and clustering advances innovation-stimulating environments in engineering education. The present research proposes phases of clustering to enhance engineering students' use of Enterprise 3.0 in tertiary education. Aim of the research is to analyze effectiveness of clustering for the development of engineering students' use of Enterprise 3.0 in tertiary education. The meaning of the key concepts of "Enterprise 3.0" and "clustering" is studied. Moreover, the study demonstrates how the key concepts are related to the idea of "engineering education". The explorative research has been used. The empirical study was conducted within the Sixth Baltic Summer School *Technical Informatics and Information Technology* at Kaunas Technical University, Lithuania, August 13-28, 2010. The sample involved 28 participants of the Sixth Baltic Summer School. Descriptive statistics (mean and standard deviation) were used for primary data analysis. The empirical results reveal that clustering with use of Enterprise 3.0 within the Sixth Baltic Summer School *Technical Informatics and Information Technology* is effective for the development of engineering students' use of Enterprise 3.0. Finally, directions for future research are proposed.

1. INTRODUCTION

Innovation – the creation, dissemination, and application of knowledge – has become a major engine of economic expansion and social development [6]. Innovations are driven by various sources [6]. The synergy between various sources serves as an innovation catalyst.

Web 3.0 which penetrates our society more thoroughly with the availability of broadband services has already been widely integrated into the contemporary processes and work environments. All dimensions of Web 3.0, namely, the infrastructure dimension, the functionality dimension, the data dimension, and the social (or socialization) dimension, as depicted in Figure 1, are on their path into the enterprise [17]. Therein, Web 3.0 includes Enterprise 3.0 used for enterprise (business) purposes. In turn, 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 [11]. Thus, the synergy between Enterprise 3.0 and clustering contributes to innovation-stimulating environments [10] in engineering education.

Aim of the research is to analyze effectiveness of clustering for the development of engineering students' use of Enterprise 3.0 in tertiary education.

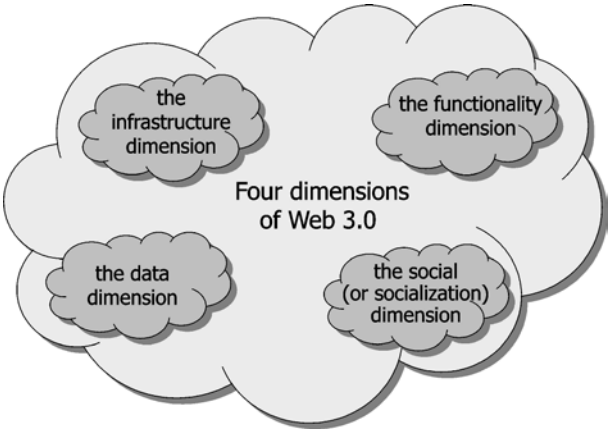

Figure 1: Four dimensions of Web 3.0

Analysis of engineering students' use of Enterprise 3.0 on the pedagogical discourse involves a process of analyzing the meaning of the key concepts of "Enterprise 3.0" and "clustering". 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: a historical perspective of the development of Enterprise 3.0→ defining Enterprise 3.0→ deter mining clustering in tertiary education→ an empirical study within a multicultural environment.

The methodological foundation of the present research is formed by the System-Constructivist Theory based on Parsons's system theory about any activity as a system, Luhmann's theory about communication as a system, the theory of symbolic interactionalism and the theory of subjectivism [4]. The application of this approach to learning introduced by Reich [14] emphasizes that human being's point of view depends on the subjective aspect [8]:

- everyone has his/her own system of external and internal perspectives that is a complex open system as shown in Figure 2 by Ahrens and Zaščerinska [2], and
- experience plays the central role in a knowledge construction process [8].

Therein, the subjective aspect of human being's point of view is applicable to the present research.

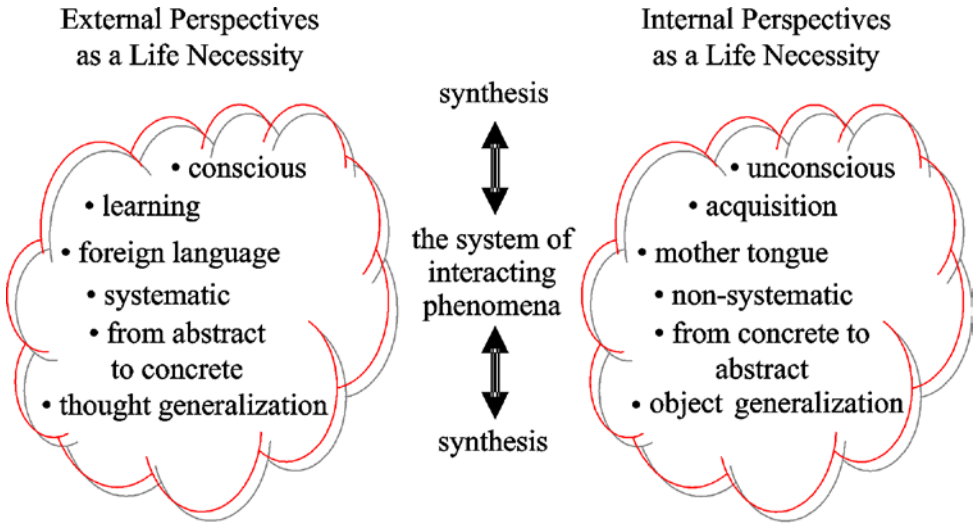

Figure 2: Developing the system of external and internal perspectives

The remaining part of this paper is structured as follows: Section 2 introduces the theoretical framework on Enterprise 3.0 and clustering. The associated results of the empirical study will be presented in Section 3. Finally, some concluding remarks are provided followed by a short outlook on interesting topics for further work.

2. THEORETICAL FRAMEWORK

A general conception of Enterprise 3.0 is determined as use of Web technologies for enterprise (business) purposes. The study of the *Enterprise 3.0* concept and pedagogical perspective on *Enterprise 3.0* has not had a long story as demonstrated in Table 1.

Table 1: Enterprise 3.0 in pedagogy in different historical periods

Stage	Historical period	Approach	Elements of Enterprise	Educational settings
1	2000 - 2006	Enterprise 1.0 as socialization	Social software	Tasks with use of Enterprise 1.0
2	2006 – up to now	Enterprise 2.0 as community	Social software and online networks	Teaching techniques with use of Enterprise 2.0
3	2007 – up to now	Enterprise 3.0 as organization	Online networks	Practice of the Enterprise 3.0 curriculum

Enterprise 3.0 is defined to be an ideal organization for the 21st century to form new business functions of collaboration with the focus on information sharing within the enterprise and the eco-system partners [12].
"Organization" and "agency" are used synonymously in many publications. However, the distinctive use of these terms is emphasized by Barker [3]. Organization is a social arrangement which pursues collective goals, controls its own performance, and has a boundary separating it from its environment [15], thereby influencing or limiting the choices and opportunities that individuals possess [3]. In turn, agency refers to the capacity of individuals to act independently and to make their own free choices [3]. Hence, Enterprise 3.0 is an agency based on the practice of curriculum [4].
Moreover, the paradigm shift from socialization within Web 2.0 to peer contribution within Web 3.0 has increased the need in sustainable communication networks. This change reveals that the elements of Enterprise 3.0 include online networks.
Online networks as a form of peer contribution today bring a dimension to the Web that goes beyond simple links between pages; they add links between people, between communities [17] and between organizations. In such a network, direct links will typically point to our closest friends and colleagues, indirect links lead to the friends of a friend, and etc.
A network on the Web is typically the result of employing some software that is intended to focus on building an online community and, consequently, organization for a specific purpose [17]. Social networks connect people with common interests and may be as simple as a blog, or as complex as Facebook or MySpace for mostly private applications, as LinkedIn or Xing for professional applications, or as Twitter for both. The primary impact that the current Web developments are having in this area are that connecting people, communities and organizations constantly becomes easier, and it is not difficult anymore to maintain a professional or personal network of buddies worldwide. Yet another impact is that a social network may open up novel sources of revenue, in particular through advertising. Finally, Vossen [17] underlines that technology enables functionality, which as a "byproduct" leads to data collections, and users have a new tendency to socialize over the Web, by exploiting that functionality and the technology.
In 1990s, *clusters* became a target for local and regional initiatives to promote competitiveness and job-creation [10]. Clusters were expected to stimulate the innovativeness and competitiveness of companies, especially small and medium-sized enterprises [10]. Therein, enterprises are a basis for prosperity and economic development.
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 [13]. 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 in a cluster over time,
- third, the establishment of contact with key persons in the state education agency to work in 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 [11]. Finally, the authors of the present research define cluster as the unity of educational and research institutions, enterprises, centres, agencies, companies and other interested organizations that implement a joint activity as depicted in Figure 3.

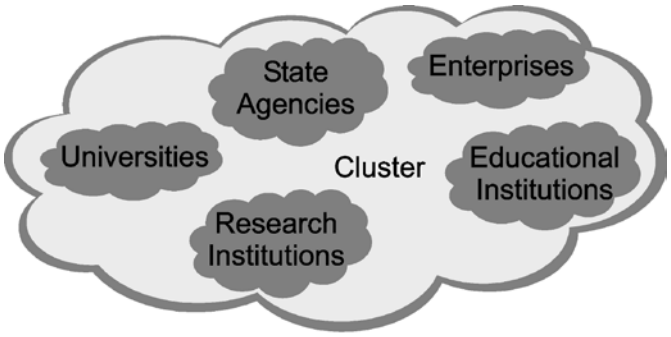

Figure 3: Components of a cluster

University as part of a cluster provides engineering students with the appropriate skills and competences for innovation and creates new knowledge within the "knowledge triangle" of education, research and innovation [6].

In its turn, clustering is determined as the cluster process or joint activity. From the point of view of the paper authors, clustering is defined as shared aim oriented joint activity as according to certain common norms, over some period of time, that provides joint social interaction and cognition for each participant and increases opportunities of gaining social experience [18]. The implementation of the cluster's joint activity comprises three phases: it gradually moves from initiation in Phase 1 to application in Phase 3 through explication in Phase 2 as shown in Figure 4 by the paper authors.

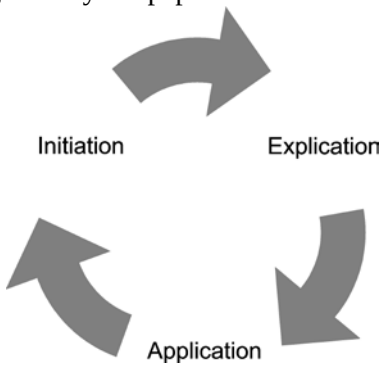

Figure 4: Phases of clustering

Each phase of the joint activity is separated from the previous one, and the following phase is based on the previous one.

The initiation phase starts with preparing the cluster participants for the implementation of the joint activity, planning its procedure, equipping the participants, determining the aim of the joint activity, etc. Then, the explication phase is aimed at making a decision. The application phase focuses on the outcome evaluation.

There are two possible forms of clustering: co-operation and collaboration. On the one hand, clustering is not provided by co-operation inside a cluster: the relationship between firms, between firms and institutions, and between the private and the public sector is weak, in particular when it comes to activities that go beyond common business transactions [10]. On the other hand, collaboration forms strong relationships inside

clusters [10] as collaboration is product orientated. Hence, the form of clustering is determined as collaboration.

3. EMPIRICAL RESEARCH

This study is oriented towards the revealing of effectiveness of clustering within the Baltic Summer School 2010 to improve the engineering students' use of Enterprise 3.0. 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.

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 [7].

An explorative research has been used in the study. The explorative research is aimed at developing hypotheses, which can be tested for generality in following studies [9]. 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 directions of further research.

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

All 28 participants of the 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 28 participants of the 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, Romania and Mexico. Whereas cultural similarity aids mutual understanding between people [16], 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 [1]. Moreover, the sample of the participants of the Sixth Baltic Summer is multicultural.

The cluster of the Baltic Summer School 2010 comprised the organizations shown in Figure 5.

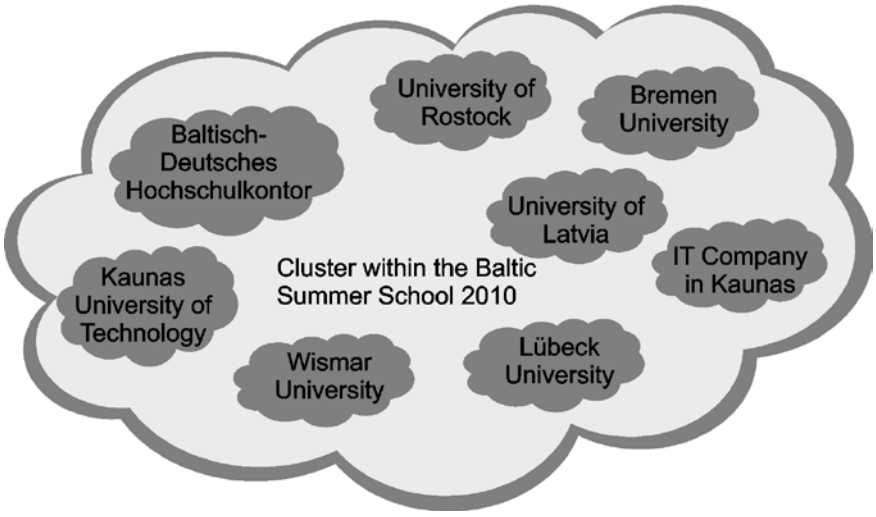

Figure 5: Cluster of the Baltic Summer School 2010 in Kaunas, Lithuania

The International Summer School offers special courses to support the internationalization of education and the cooperation among the universities of the Baltic Sea Region. The aims of the Baltic Summer School *Technical Informatics and Information Technology* are determined as preparation for international Master and Ph.D. programmes in Germany, further specialization in computer science and information technology

and learning in a simulated environment. The 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 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 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.

Between the pre- and post-survey of the participants' use of Enterprise 3.0 clustering with use of Enterprise 3.0 technologies, namely, online networks, was implemented within the Sixth Baltic Summer School *Technical Informatics and Information Technology*. In order to promote engineering students' use of Enterprise 3.0, clustering involved visiting an IT company in Kaunas, courses in technical informatics and information technology, 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. Clustering with use of online networks of Enterprise 3.0 technologies was implemented in a variety of forms, namely, discussion, prepared talk, communication games and information-gap activities within the Baltic Summer School 2010.

Criteria of use of Enterprise 3.0 in engineering education are based on student engineers' needs. Need is defined by the reasons for which the student is learning [5]. A need can vary from study purposes, for example, following a course in Enterprise 3.0, to work purposes, for example, participating in business and/or working in an enterprise. Thereby three groups of needs are outlined:

- use of Enterprise 3.0 for individual purposes,
- use of Enterprise 3.0 for organizational purposes and
- use of Enterprise 3.0 for professional purposes.

By individual purposes private use of Enterprise 3.0 is meant: business functions are used within the family and friends. By organizational purposes use of Enterprise 3.0 between the colleagues is determined: business is made between the participants within the enterprise. And by professional purposes Enterprise 3.0 is used for business with the partners of the enterprise. These needs are the starting points which determine what should be taught [5].

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.

After having implemented the process of clustering with use of online networks of Enterprise 3.0 technologies, the results of two surveys of the participants' needs in use of Enterprise 3.0 within the Sixth Baltic Summer School 2010 demonstrate the positive changes in comparison with the pre-survey:

- the level of the participants' experience in terms of knowledge of the concept of Enterprise 3.0 has been enriched,
- the level of the participants' experience in terms of use of Enterprise 3.0 for individual needs, for organizational and professional needs increased and
- the level of the participants' experience in terms of participation in activities for professional development, namely, education, in-service training and/or learning, in use of Enterprise 3.0 has been improved.

The *Mean* results of the descriptive statistics as highlighted in Table 2 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 2: 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 comparison of the *Standard Deviation* results as shown in Table 3 reveals that the scores of the post-survey are spread wider than the scores in the pre-survey. Therein, in the pre-survey the levels of the students' use of Enterprise 3.0 are homogeneous and in the post-survey – heterogeneous.

Table 3: 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

The surveys of the students' needs in Enterprise 3.0, as emphasized in Table 2, reveals that the students do not realize the possibilities offered by Enterprise 3.0 properly. The results of *Mean* and *Standard Deviation* within the surveys of the students' 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 3.0 technologies.

4. CONCLUSIONS

The empirical results reveal that the process of clustering with use of Enterprise 3.0 within the Sixth Baltic Summer School *Technical Informatics and Information Technology* is effective to contribute to the engineering students' use of Enterprise 3.0.

Thus, it might be stressed that clustering is effective if students' needs are met and a support system is created that would secure their learning outcomes, students demonstrate better results.

The present research has limitations. Use of Enterprise 3.0 in the Sixth Baltic Summer School was studied paying attention to the students' needs. Therein, view of educators and researchers on students' needs in use of Enterprise 3.0 is necessary to analyze. Another limitation is the empirical study conducted by involving the students of one tertiary institution. Therein, the results of the study cannot be representative for the whole area. As well as the empirical study outlines the opportunities of the development of students' use of Enterprise 3.0. Nevertheless, the results of the research, namely, the process of clustering and the stages of

the empirical study, may be used as a basis of the development of students' use of Enterprise 3.0 of other tertiary institutions. Moreover, 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.
Enterprise 3.0 demonstrated the technology of online networks to assemble and manage large communities with a common interest in peer contribution, where organisations and enterprises have made use of the potential of Web 3.0 with single solutions such as online networks. However, Enterprise 4.0 as demonstrated in Table 4 will be derived from the full application of Web 4.0 concepts such as ambient intelligence, WebOS or Web operating system, artificial intelligence, rather than Web 3.0 point solutions.

Table 4: Enterprise 4.0 in pedagogy in different historical periods

Phase	Historical Period	Approach	Elements of Enterprise	Educational settings
1	2000 - 2006	Enterprise 1.0 as socialization	Social software	Tasks with use of Enterprise 1.0
2	2006 - up to now	Enterprise 2.0 as community	Social software and online networks	Teaching techniques with use of Enterprise 2.0
3	2007 - up to now	Enterprise 3.0 as organization	Online networks	Practice of the Enterprise 3.0 curriculum
4	2010 - up to now	Enterprise 4.0 as society	Ambient intelligence, WebOS or Web operating system, artificial intelligence	University Degree

This remains as an open point for the future as depicted in Figure 6. It should be mentioned that the concept of a Web operating system or WebOS is distinct from Internet operating systems. Web operating system or WebOS is independent of the traditional individual computer operating system.

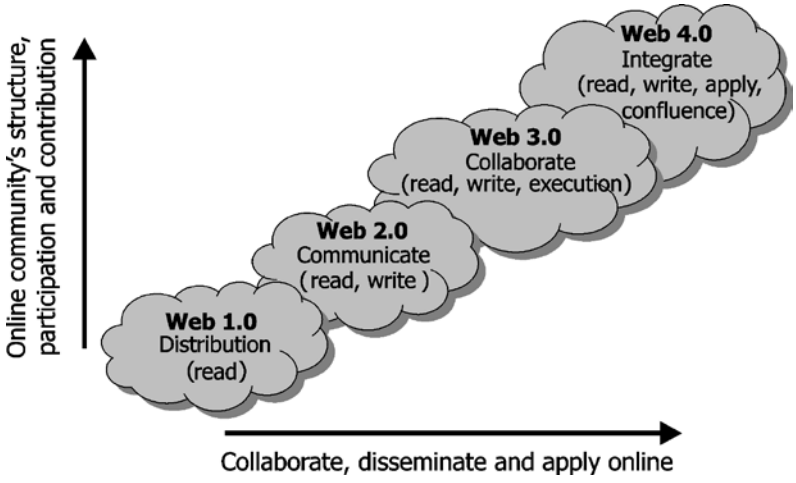

Figure 6: Web 3.0 and beyond

5. REFERENCES

[1] Abasheva, C.: "Specifics of the English Language Education in the Study Groups with Different Mother Tongues" *5th International Scientific Conference Theory for Practice in the Education of Contemporary Society of Riga Teacher Training and Educational Management Academy,* Riga, Latvia, 25-27 March 2010, pp. 428-431.

[2] Ahrens, A., Zaščerinska, J.: "Social Dimension of Web 2.0 in Student Teacher Professional Development" Association for Teacher Education in Europe Spring Conference 2010: *Teacher of the 21st Century: Quality Education for Quality Teaching*, Riga, Latvia**,** 7-8 May 2010, pp. 179-186.

[3] Barker, C.: *Cultural Studies: Theory and Practice*. London: Sage. 2005, pp. 20-25.

[4] Bassus, O., Zaščerinska, J., Ahrens, A.: "From Enterprise 2.0 to 3.0: Challenges in Engineering and Business Education" *Information and Communication Technologies in Engineering and Business,* Berlin: Mensch & Buch, 2011, pp. 79-96.

[5] Dudley-Evans, T., John, M.: *Developments in English for Specific Purposes. A multi-disciplinary approach*. Cambridge University Press. 1998, p. 2.

[6] Lifelong Learning for Creativity and Innovation: *Lifelong Learning for Creativity and Innovation. A Background Paper.* February 2008, pp. 1-20.

[7] Luka, I.: "Students and the educator's co-operation as a means of development of students' ESP competence" *European Conference on Educational Research*, University of Goteborg, 10-12 September 2008, pp. 1-12. http://www.leeds.ac.uk/educol/documents/172916.htm.

[8] Maslo, E.: "Transformative Learning Space for Life-Long Foreign Languages Learning" *International Nordic-Baltic Region Conference of FIPLV Innovations in Language Teaching and Learning in the Multicultural Context*. Riga, Latvia, 2007, pp. 38-46.

[9] Mayring, P.: "On Generalization in Qualitatively Oriented Research" *Forum Qualitative Sozialforschung / Forum: Qualitative Social Research*, 8(3), Art. 26. 2007, pp. 1-8.

[10] Meyer-Stamer, J.: "Clustering and the Creation of an Innovation-Oriented Environment for Industrial Competitiveness: Beware of Overly Optimistic Expectations" *Paper prepared for International High-Level Seminar on Technological Innovation*, Beijing, China, September 5-7, 2000, p. 2.

[11] Mills, K., Reynolds, E., Reamer, A.: *Clusters and Competitiveness: A new federal Role for Stimulating Regional Economies.* Brookings, 2008, pp. 3-6.

[12] Nadhan E. G.: "Forecast for the Next Generation Enterprise 3.0" *EDS Distinguished SE Open Group Enterprise Architecture Practitioners Conference*, Chicago, 23rd July 2008, p. 2.

[13] Nahtigal, P.: „Clustering for School Improvement. A Report on Rural Clusters" Mid-Continent Regional Educational Lab, Aurora, Colorado. February 4, 1985.

[14] Reich, K: *Systemisch-konstruktivistische Pädagogik*. Weinheim:Beltz, 2005, pp. 15.

[15] Robbins S. P., Odendaal A., Roodt, G.: *Organisational Behaviour: Global and Southern African Perspectives.* Cape town: Pearson education. First edition. 2003, pp. 15-25.

[16] Robbins, D.: "Vygotsky's and Leontiev's Non-classical Psychology Related to Second Language Acquisition" *International Nordic-Baltic Region Conference of FIPLV Innovations in Language Teaching and Learning in the Multicultural Context.* 15-16 June, 2007, Riga, Latvia, - Rīga: SIA "Izglītības soļi", 2007. pp. 47-57.

[17] Vossen, G.: "Web 2.0: a Buzzword, a serious Development, just Fun, or What?" *International Joint Conference on e-Business and Telecommunications.* Milan, Italy, 2009, pp. IS33-IS40.

[18] Zaščerinska, J.: "Social Dimension of Web 3.0 in Engineering Education" *Information and Communication Technologies in Engineering and Business*, Berlin: Mensch & Buch, 2011, pp. 101-130.