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THE NEW GENERATION OF VIRTUAL LEARNING ENVIRONMENTS IN LITHUANIA

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Abstract. E-learning development in Lithuania can be traced back to early nineties and pilot projects, mainly supported by European funding initiatives. Many projects resulted in new content and spontaneous expansion. Yet each institution over and over again invented its' own approach to e-learning. In this paper we present e-learning process taxonomy as an expert based method to validate completeness of a virtual learning environment. E-learning is broken down into roles, groups and relationships. E-learning processes and related technologies are presented as bound actions particular for every actor group. Process taxonomy is applied to evaluate learning information systems in Lithuania. The paper is summarized by drawing certain recommendations resulting from the taxonomic analysis, articulating the core need for integration of diverse information systems and XML standards, as the core premise, to achieve this goal.

Keywords. E-learning taxonomy, virtual learning environments, generations of virtual learning environments, e-learning technologies, content development tools, videoconferencing, e-learning standards, integrated e-learning information system.

1. Indroduction

Distance learning is foremost related to information communication technologies and is defined as the use of networked information and communications technologies (ICT) to extend, enhance and enrich learning activity 0. However, this definition of e-learning is just only one of many. Other authors propose: “e-learning can be defined broadly as any use of Web and Internet technologies to create learning experiences” 0 or “E-learning utilizes computers and computer networks as an additional and complementary channel of communication; connecting learners with learning media, with other people (fellow learners, sources, facilitators), with data (about learning, about media, about people) and with processing power” 0. In any case, “all of these terms imply that the learner is at a distance from the tutor or instructor, that the learner uses some form of technology (usually a computer) to access the learning materials, that the learner uses technology to interact with the tutor or instructor and other learners, and that some form of support is provided to learners” 0.

According to the above mentioned definitions we reason that the learner is the person number one in e-learning. All the technologies are there to empower the learning, meet learners’ needs and make learning a seamless experience. Malins and Pirie articulates natural immersion aspect of e-learning technologies in their paper 0: “It is also important that VLEs reflect the nature of the discipline by providing a well-designed, visually stimulating environment that genuinely supports the real world learning environment.” In ideal case student should not notice the technologies at all in the personalized virtual learning environment (VLE).

As many authors [18, 19, 20] note, in e-learning the major workload shifts from teaching to course development. For all different e-learning types 0 ICT technologies are there as a secondary means matching learning needs of the institution. Thus it is very important firstly to evaluate institution needs and secondly match those needs to the particular e-learning technologies, concrete tools implementing those technologies. Lastly, chosen VLE is validated and re-evaluated based on given criteria, which again evolute upon time passing by. Therefore in the second part of this paper we present e-learning process taxonomy as a method for validation of VLE and share our experiences implementing this method to implement

new generation of VLE in Lithuania. In the next section we briefly overview the VLE generations in Lithuania fundamental premises for our experiences and further development of the infrastructure.

2. E-learning evolution in Lithuania

E-learning development in Lithuania can be traced back to early nineties and pilot projects mainly supported by European funding initiatives (PHARE, Copernicus, INCO-Copernicus, Leonardo and others). More than 30 projects focused on different target groups resulted in new e-learning content. Yet throughout all of those projects each institution continued the search for ideal e-learning platform. In this paper we present our up-to-date understanding of integrated learning platform and its implementation at nation wide LieDM consortium.

2.1. VLE generations in Lithuania

Looking back at the e-learning development in Lithuania we see following evolution steps:

1. Learning materials with scripts.
   First projects resulted in lots of content developed, which yet being static was enriched with individual client-server scripts. While some of the courses were produced as CBTs and delivered on CD media, others were web based courses and already had some lightweight anonymous self-test engine included. Concisely this e-learning generation can be described as follows: anonymous non personalized content with tools to increase interactivity level of material.
2. Own learning platform.
   The number of learning tools grew; some integration attempts have been made. This provided means to envision own platform for e-learning. The ownership was two fold – the sky is the limit to implement something new and yet always unleashing software bugs were driving organization transformation from focused on education into a software development house. Learning this lesson took some time, but finally professional learning platform has been chosen and university could again focus time and resources on what it is aimed at – education.
3. A set of information systems.
   As infrastructure establishment elaborated in deployment of professional stand-alone information systems: Library system (ALEPH), Virtual learning environment (WebCT), Course development kit (CDK), streaming media (both synchronous and asynchronous) e-learning component (ViPS), PeopleSoft Campus information system and others. Working well as stand alone components those systems yet do not offer cohesive learning experience as there is no connection between different information bits covering a variety of learning aspects: information sources (library system), course bookings and student allocations (student information system), course development and teaching and so on. All the different information systems work well and provide all what they are supposed to, but on the other hand missing integration decreases student experience as lots of potential added value of integrated system interoperation is missing.
4. Integrated virtual learning environment [15].
   It is a next step which is undertaken under current LIEMSIS information integration project.

At the same time video conferencing network was developed and was used to deliver to country wide spread auditorium. Later conferences were simultaneously recorded into ViPS for on-demand review 0. Next we explore the evolution of teaching and learning process.

2.2. Teaching and learning process

Everybody who is able to speak is able to share his perception of the world to others and it is unspoken truth that everyone is able to teach. Especially if we consider research/technology based higher education institutions, we see that the majority of teaching professors have no background in education. This is due to the fact that classical university teaching is an extension of natural communication combined with the ability to clearly express own thoughts.

Yet in e-learning or blended learning, the communication shifts to a virtual environment. Usual skills of communication and education are no longer sufficient and the methods of “sage on the stage” teaching are no longer valid 0. New learning environment has lots of advantages for students (flexibility of time, place and pace etc), but also demands much more qualification from the teaching staff. As quantitative study done by Chen, Lin and Kinshuk 0 shows the learning environment and teacher qualification are the two core critical aspects for student satisfaction in e-learning.

In virtual learning environments the technical implementation reshapes learning experience, which in process of learning is yet affected by course subject and learning specific communications. Based on this we see that the complexity of e-learning has three constituents:

1. Subject expertise.
2. Technical expertise.
3. Knowledge of educational process in virtual learning environment.

Based on this we note that e-learning becomes a complex process and demands professional infrastructure, staffing and management. Thus there is an immense need for e-learning process taxonomy, laying grounds on all aspects of complex e-learning organization: participants, roles, responsibilities and processes, technologies involved etc.

Further on, after presenting the e-learning process taxonomy we evaluate on how well current situation

covers e-learning processes and summarize with certain suggestions for further development.

3. E-learning process taxonomy

B. Khan writes: "To create a meaningful open, flexible and distributed learning environment for diverse learners, we must explore important issues encompassing various dimensions of e-learning environment" 0. Exploring the internals of e-learning we discover numerous systemically interrelated and interdependent factors. B. Khan also states that: "A systemic understanding of these factors can help us create meaningful flexible and distributed learning environments" 0.

We consider e-learning break out into constituent parts is the core for evaluation and design of new generation of VLE as well as essential for standardization of e-learning processes and organization 0. Next we elaborate on the main concepts of proposed e-learning process taxonomy method. Not only we propose the method for theoretical discourse, but rather we deploy it for practical validation of completeness of e-learning process coverage by certain chosen VLE.

3.1. VLE validation method

W. Horton writes: "The most painful question we get as consultants is "What tool should I use for e-learning?" What is painful about the question is that it shows the questioner has been misled to believe there is one single tool that does everything everybody needs to do to create, host, and access e-learning. Successful e-learning projects may require dozens of software products chosen from hundreds of candidates sprawling across several categories." 0. However, the question is not as bad as it is painful. Since questioner understands that e-learning as well as VLE requires many different tools, he should ask what type of tools should be used to support e-learning and create flexible VLE, which fits the best well-known teacher and learner needs.

To answer the question we need a framework or a checklist of the major categories of technologies needed in e-learning. However, as W. Horton writes: "Technology doesn't make e-learning. People do. The right starting point for any exploration of technology is the people for whom the technology is needed." 0. Therefore, at this point it is very important to outline the actors, roles and their responsibilities, produce a list of those who facilitate e-learning from alpha to omega. Only after we know who takes part in each stage of e-learning process and processes, functions for which he or she is responsible, we are able to answer which technologies may be used to facilitate his or her work.

Structured e-learning actors, functions and technology break down, is our method towards systematic validation of VLE coverage of e-learning process. As mentioned above, VLE of new generation does not decline the work done so far, but rather includes all tools into cohesive backbone architecture, based on e-learning standards and open for future needs and extensions. In area of complex relationships of diverse information systems there is no way of having single solution, which fits all, needs out-of-the-box. Proposed open architecture provides tools and technologies allowing information sharing, integration of unique institution specific learning plugins or extensions. Following e-learning process standardization every e-learning actor is responsible for his own set of functions and uses only technologies related to his competencies. However his work and synergistic result of whole team is useful for all e-learning participants. Therefore our VLE validation method gives answers for:

1. Starting organizations' questions: who must take part in e-learning process, what he or she must do and what technologies may be used in e-learning process.
2. For advanced organizations' questions: how well the current set of technologies covers e-learning functions and processes, what are the actors and their roles in concrete organization which develops e-learning.

3.2. E-learning process cycle

E-learning as it comes to university starts from research projects, elaborates into pilot projects and finally is accepted as strategic constituent of academia. However, in order to form a complete list of e-learning actors, complete e-learning process cycle has to be known. D. Rutkauskienė presents this cycle in the dimensional open and distance learning model "Multilayer roulette" 0. In her model we points all stages of open and distance learning process, shows the sequential transitions between stages of e-learning process cycle and describes the interfaces of particular activities.

The dimensional model "Multilayer roulette" is used because e-learning is considered as multilayer phenomenon 0. Consequently, it is possible to outline the following three constituents:

1. E-learning course development (user needs analysis, course content and form).
2. E-learning process management and administration.
3. Teaching and learning process.

According to this model as well as to overall e-learning experience we reason that the most important part of e-learning process is development – preparation part.

In fact, e-learning course design and development defines the third part – teaching and learning. In Figure 1 we show stages of e-learning course evolution. Also we articulate course development as most important part of e-learning process cycle, typically defining follow up tutor teaching activities.

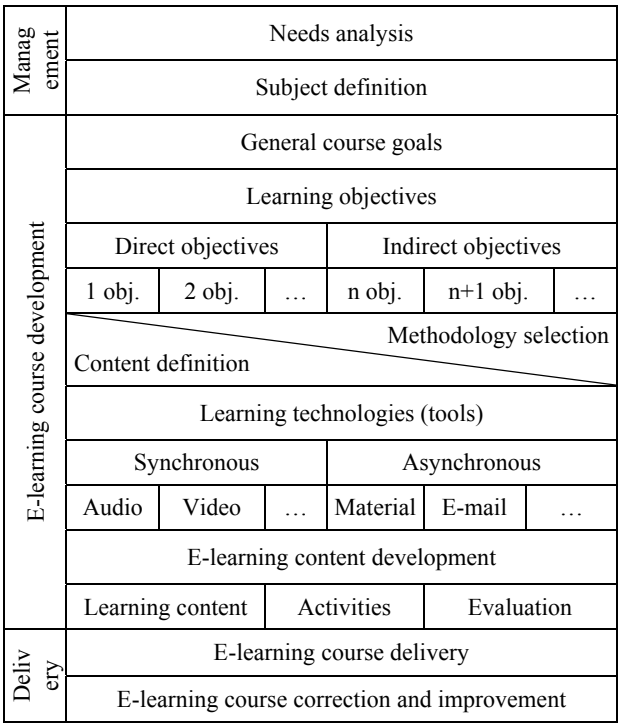

Figure 1. Stages of e-learning course evolution

Stages of e-learning course evolution present general sequence of activities and e-learning actors, responsible for them. Based on this figure we see the moment of learning technology choice. It is particularly important to note that selection of the technologies is tightly coupled to the methodological objectives. Therefore, we reason that technology selection as well as learning activity selection should be done in one – general sequence of e-learning process cycle.

3.3. E-learning actors, processes and technologies

As mentioned above, in order to find out e-learning participants, their functions, relationship of those to learning processes as well as to learning technologies in Tables 1 and 2 we break down e-learning complexity into three major constituents:

1. Actors (answering the question "Who?"),
2. Responsibilities and processes (answering the question "What?"),
3. Technologies (answering the question "How?").

C. Shepherd writes: "To fulfill all the demands of an e-learning project requires many different skills, certainly more than you can reasonably expect of any single person, however multi-talented. These skills can be thought of as more or less pedagogical (concerned with learning), technical (concerned with the computers and the networks) or creative (concerned with the development of engaging content). At the centre of these three sits what is perhaps the most difficult skill of all – integrating all this together through strategic and project management." 0. According to this thinking and to the checklist of B. Khan 0 we set four main e-learning processes as well as people groups:

1. Management (administration, consultants, etc.).
2. Content development (content experts, e-learning experts, developers, etc.).
3. Content delivery (administrators, tutors, teachers, assistants, etc.).
4. Learning (students).

This ideology also proves W. Horton and writes that: "The process of building e-learning is commonly referred to as creating, and it is performed by the producer. The next process is offering, performed by the host. The process of taking e-learning is commonly referred to as accessing and is performed by the learner." 0.

Table 1. Actors, groups and their responsibilities for e-learning processes

Role of Individual	**Responsibilities and processes**
	Management process
Director	Directs e-learning initiatives. Develops e-learning plans and strategies.
Project manager	Supervises the overall e-learning process including: design, production, delivery, evaluation, budgeting, staffing and scheduling. Works with coordinators of various e-learning teams.
Business developer	Develops business plan, marketing plan, and promotion plan. Develops new learning programs.
Consultant / Advisor	Provides independent, expert advice and services during various stages of e-learning.
	Content development process
Researcher	Coordinates e-learning research processes. Informs management team about the latest data pertaining to online learning activities and research.
Subject expert	Writes course content and reviews existing course materials (if any) for accuracy and currency.
E-learning expert (education)	Provides consultation on e-learning strategies and scenarios.
E-learning expert (technology)	Provides consultation on e-learning technology: content, delivery and communication formats.
Designer	Responsible for site design, navigation, accessibility and usability testing. Responsible for reviewing interface design and content materials.
VLE developer	Responsible for getting all pieces of e-learning (e.g., Web pages, chat rooms, Java applets, e-commerce, etc.) working together under a virtual learning environment.

Editor	Reviews e-learning materials for clarity, consistency of style, grammar, spelling, appropriate references and copyright information.
Multimedia Developer	Responsible for creating multimedia learning objects such as audio, photography, video, 2D/3D animations, simulations, etc.
Learning standards expert	Guides the design, production and meaningful storage of learning content by the following internationally recognized standards (e.g., SCORM, AICC, IEEE, etc.).
Quality Assurance	Responsible for quality control in e-learning.
	Content delivery process
VLE administrator	Administers VLE server and user accounts.
System administrator	Administers VLE server and network security.
Teacher	Teaches online courses.
Teacher assistant	Assists the teacher or trainer in instruction.
Tutor	Assists learners in learning tasks.
Technical support specialist	Provides both hardware and software related technical help.
Library services	Interactive library services for learners who can ask questions to librarians about their research both asynchronously and in real time via the Internet.
	Learning process
Student	Learns in online courses.

There is a diverse variety of technologies providing means to facilitate all the different e-learning actors, groups and their activities. As N. van Dam writes: "There is currently a wide range of technology-based products and content-based solutions available in the e-learning market. 0. Also author writes "there are a few generally accepted categories of products":

- Learning management systems,
- Learning content management systems,
- Content development tools,
- Collaborative learning tools,
- Live e-learning (synchronous) tools,
- Assessment tools,
- Human Resource Information Systems,
- Learning portals.

Each category of mentioned technologies mainly matches one or more people groups. Therefore some technologies in these groups may have intersections. In Table 2 we outline the relationship between e-learning actor groups, processes and learning technologies.

Table 2. Technologies for e-learning processes' implementation and support

Technologies	**E-learning groups and processes**			
	Management	**Content development**	**Content delivery**	**Learning**
Text processing	X	X	X	X
Syllabus		X	X	X
Learning design		X	X	
Image processing		X		
Animation processing		X		
Simulation processing		X		
Audio processing		X		
Video processing		X		
Presentation processing		X	X	X
Multimedia repository		X	X	X
Resource management		X		
Learning object management		X		
Digital library		X	X	X
Email	X	X	X	X
Calendar	X	X	X	X
Bulletin board	X	X	X	X
Discussion forum			X	X
Text based chat			X	X
Audio conference			X	X
Video conference			X	X
Collaborative browsing			X	X
Group projects			X	X
White board			X	X
Shared applications		X	X	X
Testing		X	X	X
Surveying		X	X	X
Classroom management	X		X	X
Tracking and reporting	X	X	X	X
Adaptive content		X	X	X
Portfolio			X	X
Diary/Blogs			X	X
Search	X	X	X	X
Glossary		X	X	X
Course library		X	X	X
Gradebook			X	X

Student homepages				X
Assignments		X	X	X
Work time tracking	X	X	X	
Enterprise resource planning	X			
Project management	X			
Intranet environment	X	X	X	X
User management	X		X	
Permission management	X			
Study module management	X			

In the checklist of technologies, which may be used for e-learning processes' implementation and support, each "X" means that this type of technology is used in appropriate process by particular group of that column. Technology/process checklist is a useful method for:

1. Evaluation of missing functions of that particular technology or tool. This information can be useful while considering potential development and extension planning.
2. Evaluation of completeness of learning process coverage of a set of learning technologies or tools.

This mapping method can be successfully applied as for macro coverage evaluation as well as for micro coverage analysis (but in this case a criterion set has to be adjusted to the particular detail of subject domain). In this case more than one "X" used in one line would be the reason to consider if the appropriate technology should not be used only in one tool and information redundancy could not be solved.

4. The new generation of VLEs

4.1. Integrated VLE

As we mentioned above the main concept of new generation VLEs is integration. This makes VLE flexible and distributed. In this section we present national e-learning backbone architecture for integrated VLE in Lithuania.

The architecture merges learning technologies and tools, which have been successfully used so far in LieDM network as separate means for different learning processes (see Figure 2). However the architecture does not make the finite set of tools. If any tool is needed it can be integrated as well as these ones. General repository is the core of the integrated VLE. It acts as a main link for the integration. Each information module in this repository is understood as learning object with its own metadata. The overall integration of tools and exchange of learning objects is based on international e-learning standards (LOM, IMS, SCORM) and data exchange technologies (XML, CVS, web services). The arrows from each tool to repository means data flow and links' directions. For example, digital library (LABT) has links to the e-learning resources – learning objects in content and media repositories; however, it makes as well uses metadata for these resources. Finally, the arrows form each tool to user repository means user usage and management, which may be done only in LieMSIS system.

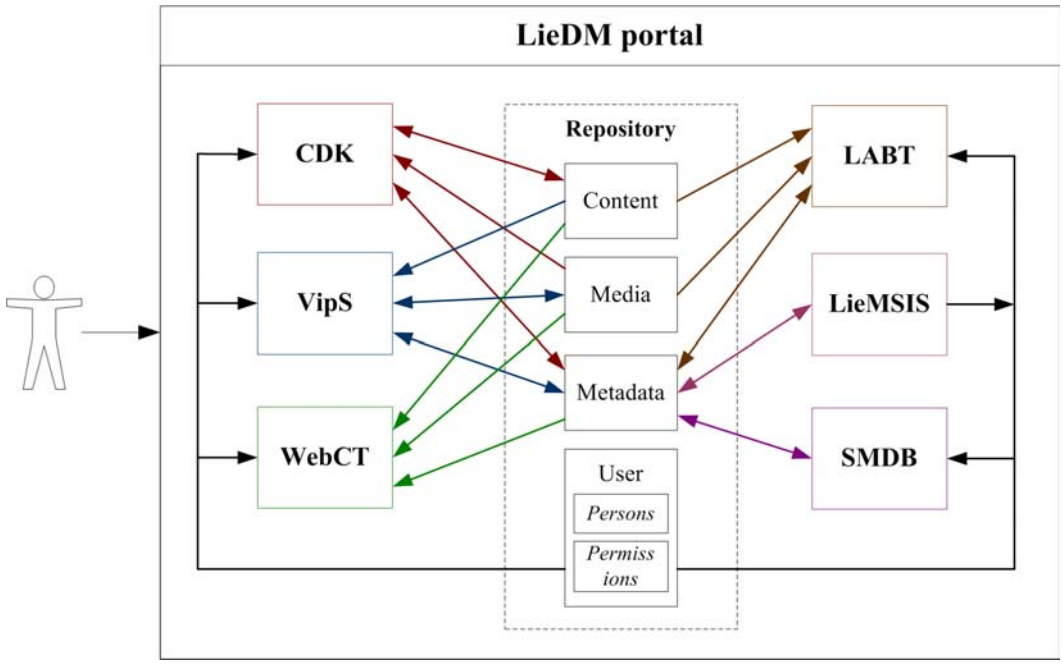

Figure 2. Integrated virtual learning environment

Integrated VLE implements full e-learning process cycle: management, e-learning content preparation, e-learning content delivery and learning. Each tool used in this architecture meets particular e-learning process and people group's requirements and is involved into this group's layer:

- LieMSIS (Lithuanian Higher Education and Research Information System) system meets management process' requirements.
- LABT (Lithuanian Academic Libraries Network) system meets digital library and learning as well as development processes' requirements.
- SMDB (Database of Study Modules) meets management, development and learning requirements.
- CDK (Course Developer Kit) tool meets e-learning material development process' requirements.
- ViPS (Video Lectures System) and WebCT (Web based Course Training) systems meet development, delivery and learning processes' requirements.

If all layers of these groups would be put on each other, we could notice that most important point in this architecture is user. According to this architecture the general user database is the essential link. The user has common login name for all systems. Using login name and central LieDM network's portal, the user is able to seamlessly connect to all integrated VLE information systems, according to his role the user acquires access to a set of tools and technologies. As we see from the architecture design as well as highlighted by W. Horton: human is most important figure in e-learning and all technologies should be used to facilitate ones activities and tasks.

4.2. NGVLE validation by e-learning process taxonomy method

In the previous section national e-learning backbone architecture has been presented. The architecture was designed including best practice technologies and considering needs and remarks created by the university community. The above mentioned architecture provides certain benefits, but even more could be gained by applying process taxonomy method.

Next, in order to validate the resulting e-learning architecture, we apply process taxonomy method. To apply process taxonomy for the concrete case, we gathered feature specifications of all constituent systems, mapped information system features into educational technologies and in Table 3 provide the resulting coverage table. Each "Y" means that the particular tool has the particular technology. Each "V" means that the particular tool should have the particular technology in the future.

Table 3. LieDM tools coverage for technologies used in e-learning

Technologies	**Tools**						
	LIEMSIS	**CDK**	**VIPS**	**WebCT**	**LABT**	**SMDB**	**Repository**
Text processing	Y	Y	Y	Y	Y	Y	
Syllabus	V	Y		Y		Y	
Learning design				V			
Image processing							
Animation processing							
Simulation processing							
Audio processing			Y				
Video processing			Y				
Presentation processing			Y				
Multimedia repository							
Resource management		Y	Y	Y	Y		
Learning object management		Y	Y	Y			V
Digital library					V		
Email				Y			
Calendar				Y			
Bulletin board				Y			
Discussion forum				Y			
Text based chat			Y	Y			
Audio conference			Y				
Video conference			Y				
Collaborative browsing				Y			
Group projects				Y			
White board				Y			
Shared applications			Y				
Testing			Y	Y			
Surveying			Y	Y			
Classroom management				Y			
Tracking and reporting			Y	Y			
Adaptive content				Y			
Portfolio							
Diary/Blogs							
Search				Y	Y		
Glossary				Y			

Course library				Y			
Gradebook				Y			
Student home pages				Y			
Assignments				Y			
Work time tracking							
Enterprise resource planning	V						
Project management							
Intranet environment							
User management	V	Y	Y	Y	Y	Y	
Permission management	V	Y	Y	Y	Y	Y	
Study module management	V					Y	

Out of this conclusive table we see that the resulting architecture has certain benefits as well as a space for growth. Process taxonomy method based integrated VLE recommendations are presented in the next section.

4.3. NVGLE conclusions and recommendations

In the previous section we concisely presented process taxonomy method application for validation of integrated VLE in Lithuania. We summarize the analysis with the following recommendations:

1. There are quite a few overlapping functions, where several tools implement the same technology. Here two groups of technologies can be outlined:
   a) General purpose technologies, such as text processing, spell checking, input validation and similar.
   b) Digital right management (DRM) technologies: user, permission, resource and learning object management.

   General purpose technologies are typically tightly integrated and are implementation specific. Thus this redundancy shall remain. Table 3 suggests that subordination amongst DRM technologies has to be defined.
2. Missing functions, where there are no tools implementing required feature.
3. Process taxonomy method (Table 3) delineates future development trends especially in the following areas:
   a) Image processing.
      For example, AXS image and 3D object real time scaling server.
   b) Animation processing.
      Preprogrammed animations are quite limited in interaction (person-computer as well as person-person). Thus animation and interaction servers could be deployed on demand as e-learning develops. For example: Macromedia Flash Communication Server MX.
   c) Simulation processing.
      There is a number of model generation and simulation toolkits available. They could be integrated into the backbone architecture as for web services or GRID components.
   d) Multimedia repository.
      This is a technology widely used amongst several e-learning groups. Since multimedia is rather labor intensive and expensive technology we see multimedia repository commonly deployed and managed by digital library information system.
   e) Portfolio.
      This is student experience record system which collects all learning experiences and outcomes and which best describes the unique combination of study areas covered throughout learner's life. This is quite a new technology although is a required one in some countries (for example, in the Netherlands).
   f) Diary/Blog.
      This is a new wave technology amongst wiki counterpart which encourages collaborative, personalized, social learning.

Observing the long list of results achieved by process taxonomy method application we nevertheless conclude that the proposed integrated VLE backbone architecture is sufficiently open and bold to advance current set of information systems and yet provide a framework for future growth.

5. Conclusions

In this paper we have reviewed e-learning evolution in Lithuania, presented process taxonomy method for VLE validation to given e-learning circumstances, practically applied process taxonomy method to investigate and validate process coverage of e-learning by new generation virtual learning environment in Lithuania.

Practical method application proved its' practical value in the following ways:

1. Clearance of e-learning process coverage by different campus information systems,
2. Clearance of function and responsibilities between different e-learning stakeholders.
3. Discovery and salvation of overlapping processes and responsibilities.

Regarding to proposed NGVLE, we suggest that e-learning standard (IMS, SCORM) implementation is the core investment into the national e-learning backbone architecture.

Regarding to the process taxonomy method we see that it could be elaborated further by introducing set

logics and mathematic reasoning for more formalized and precise result achievement.

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