INFORMATION SYSTEM BASED ON THE LEARNING CURVE MODEL FOR PROFESSIONAL COMPETENCES DEVELOPMENT

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Abstract. Pragmatic external world – employers, market – dictate the needs and demands for education today, hence its influence on the higher education system, which responds to these, is supplying learners with the ordered professional competences, knowledge and skills forged by means of various academic disciplines and courses. Needs and demands of individuals are formed under the needs and demands of the competitive global marketplace and the job market – the society – the system which guarantees its citizens the main rights for education and employment.

The responsibility of contemporary higher education providers is to yield to the new imperative of interdisciplinary connectedness of knowledge and skills, to work out educational modules which are in compliance with the tasks and demands of employers, particular businesses and the European job market

Language as a means of communication and cooperation is also a major way of access to different cultural manifestations; it is an imperative arising out of the needs, ties and interrelationships of people entering the „interdependence age" within a new space – the integrated European society. The status of English as a „Language for International Communication" is no longer in dispute and rarely attracts the kind of critical scrutiny.

In this paper we propose some certain definitions to pedagogical phenomena in the process of language acquisition on the basis of the General Systems Theory developed by an Austrian scientist Ludwig von Bertalanffy (1940s). We consider a group of learners as a *learning system* which is reversely charged with a situational *managerial system* (i.e. mentoring/teaching staff), thus, forming a constituent structural unit of a bigger pedagogical system but, at the same time, keeping its all main characteristics. Since the learning system experiences a purposeful external pedagogical influence, it is considered a managed system. A model of *Intelligent System Management* has been worked out.

The process of imparting educational information by a mentor is distinguished by its qualitative and quantitative indices. We regard it as a process of *intellectualization* of a study group in connection with the notion of 'homeokinetic plato' (according to von Bertalanffy), which actually reflects different intellectual levels of language acquisition by learners. The proposed *System of Intelligence Levels* and the *Teaching Efficiency Indicator* ensure the possibility to estimate the initial level of learner intelligence and the final result and compare these with a predetermined purposeful goal to see the efficiency of a study course and the progress of student achievement. These techniques can be recommended for use to a variety of educational and training domains.

The empirical results gave grounds to compile effectively the material amount for the final test on Business English and to define the time for its fulfillment. *Optimization Model* of teaching information amount and time distribution has been worked out and the *Learning Curve Model* has been proposed.

Keywords. System approach, intelligent system, managerial provision, instructional events, language database, knowledgebase, language decoding, homeokinetic plato, intelligence level, intellectuality, teaching efficiency indicator, study material optimization, professional communicative competences, English teaching, European identity.

Short title of the paper. Learning Curve Model.

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Introduction

As the 21st century unfolds, educational environment becomes a new supercomplex system with a constantly changing pattern. Being engaged in this environment, each of us performs tasks strategically using our specific competences to achieve a certain result. Although these tasks might not always be language-related, they are mostly accomplished through language relationships. These relationships form a spectrum of intelligent socio-language system. Here we can see the first modern signs that learning is considered to be a holistic process in a holistic world [1-3].

The analysis of numerous definitions of the notion *system* has given us the grounds to consider a group of learners in the educational environment as a system, as a component part of a bigger pedagogical system, keeping its all main characteristics. We refer to the notion educational system only as to the academic process organized within one particular educational institution. In our view, an *educational system* – is a purposefully organized wholeness of interactive components with constant reverse ties forming an integrated learning environment, which presupposes the appearance of new integrative qualities in the process of intellectualization and, eventually, leads to restructuralization of both the single constituents, and the system as a whole. An integrated learning environment includes the whole gamut of social, psychological, cultural, educational and environmental factors as both influences and resources from which individuals can draw.

1. Plugging the language into the European society

The responsibility of contemporary higher education providers is to yield to the new imperative of interdisciplinary connectedness of knowledge and skills, to work out educational modules which are in compliance with the tasks and demands of employers, particular businesses and the European job market. Integration of the European society very much depends on what instruments we will apply to promote the unity of science through improving the communication among young specialists to enhance cooperation and co-creation of a unified sustainable society. Integrated trans-disciplinary module cycles aim to ensure learning and assessment on the basis of the System approach so that individuals could understand and be given the competency, creativity and confidence to cope with the urgent professional tasks and changes, problem-solving and situation-specific reactions not only within the European society but also globally.

Information Systems Management University (ISMU), accredited by Education USA TC as an authorized testing language centre of Test of English for International Communication (TOEIC) in Riga (Latvia), has a certain experience in developing such interdisciplinary modules as well as in quantitative analysis of the testing results of the TOEIC modular sections within the framework of Business English, when educational language environment serves as the basis for trans-disciplinary cooperation in Management and Information Technologies [4,5,12]. On the basis of the System approach, the authors have worked out the criteria and quantitative indices of interim and final results of students' achievement in the target language acquisition in the course of trans-disciplinary modular learning. Using these data the authors have calculated and worked out the Learning Curve for the TOEIC test at Information Systems Management University, reflecting the necessary time and content modules to achieve higher levels of language proficiency.

2. The System approach in developing language communicative competence

The General System Theory (GST) developed by Ludwig von Bertalanffy in 1940s [6] gives primacy to interrelationships, emphasizing shifts from constituent parts to the organization of parts. It is from these dynamically managed communicative interrelationships that new properties of a learning system (a group of learners) emerge [5]. An example is the properties of these letters which, when put in order, can give rise to meaning which does not exist in the letters by themselves. This further explains the integration of tools, like language, that helps create a vibrant and innovative competence-based educational system – a system where students develop high-level competences, which include initiative, leadership, managerial ability, and the ability to communicate effectively.

The System approach ideally serves language acquisition – developing language communicative competence – since it views a language user primarily as a 'social agent', i.e. a member of society who has tasks to accomplish in particular circumstances, in a certain domain, in a specific environment. The GST, in its integrative role, brings together principles and concepts from general human competences (knowledge of the world, socio-cultural knowledge) with a more specifically language-related communicative competence (linguistic, sociolinguistic, pragmatic competences). Still, communication cannot be about nothing. In its trans-disciplinary function it encompasses a lot of domains – historical, geographical, social, political, economic, technological, cultural, environmental, and many others, demanding a certain amount of knowledge and awareness. In our case, the English language is the instrument for developing socio-cultural and occupational competences in international tourism, business, management and computer technologies.

3. Communicative competence in the European speech community

Any education begins with the language. In the process of integration and citizenship education in Europe, our main aim as higher education providers is to ensure every individual the ability to use English for international communication to guarantee everyone his share in the stakeholder involvement - education and employment in that country which one has consciously chosen to identify with the future profession or interest (sports clubs, scientific societies, interest groups, etc.) and not obligatory in the country that they themselves have not chosen to belong, depending on the place of birth and parents. Such multiple possibilities enhance motivation to study languages.

To identify the necessary competences to be developed for the benefit of future young specialists is the first step in setting educational goals. For English language educators the most problematic aspect of defining English as an international language (EIL) remains the notion of competence for EIL. It is clearly inappropriate to teach

language that is only applicable in limited situations in a target culture that may never be visited by students. It is obvious that what makes „appropriateness" in international communication cannot be defined in terms of a single speech community. Still, there is no a European speech community so far. In this early stage of the development of our European speech community, it is clear that there has to be an agreed body of standard international English to be learnt or taught for competent European communication. The notion of *communicative language competence* has to be re-considered for the teaching of English for international communication. It cannot be reduced to a single, limited, mono-cultural concept.

"International" communication seems to require a set of interdependent competences that reinforce each other – linguistic competences (include lexical, phonological, syntactical knowledge and skills), sociolinguistic competences (refer to the socio-cultural conditions of language use, especially between representatives of different cultures – rules of politeness, norms governing relations between generations, sexes, classes and social groups, certain fundamental rituals in a community) and pragmatic competences (focus on achieving mutual understanding – intelligibility- in spoken or written texts, concerning, as well, the mastery of discourse, cohesion and coherence, eliminating ambiguity) [2]. Strategic competence is also highlighted as an important component of "communicative competence" [8,9].

The theory of dynamic development cannot be restricted only to the presence of a determined goal. It demands certain conditions including organizational and structural composition of the process of development.

4. Intelligent system structural organization and management

Systems, management, intellectuality and their interrelation – these are the issues without a clear understanding of the essence of which it is not possible to study neither any problems nor dynamic or developmental processes in any domain. According to von Bertalanffy, at the foundation of any material dealing with systems there lies The General Systems Theory or The General Management Theory, which only allows working out the meaningful notions and definitions.

In our case, the educational system has an organizational structure that carries all the peculiarities characteristic of a complex system. We can single out the following:

i) objects (learning system – mentor/managerial system);
ii) elements (aims – content/educational information – methods/means/strategies – resources - forms of education, training, development) ;
iii) attributes (properties of constituent subjects);
iv) interactions or attitudes;
v) the presence of direct and reverse ties;
vi) the presence of levels and their hierarchy.

We can present the organizational structure of the educational system in the following way - see Fig.1.

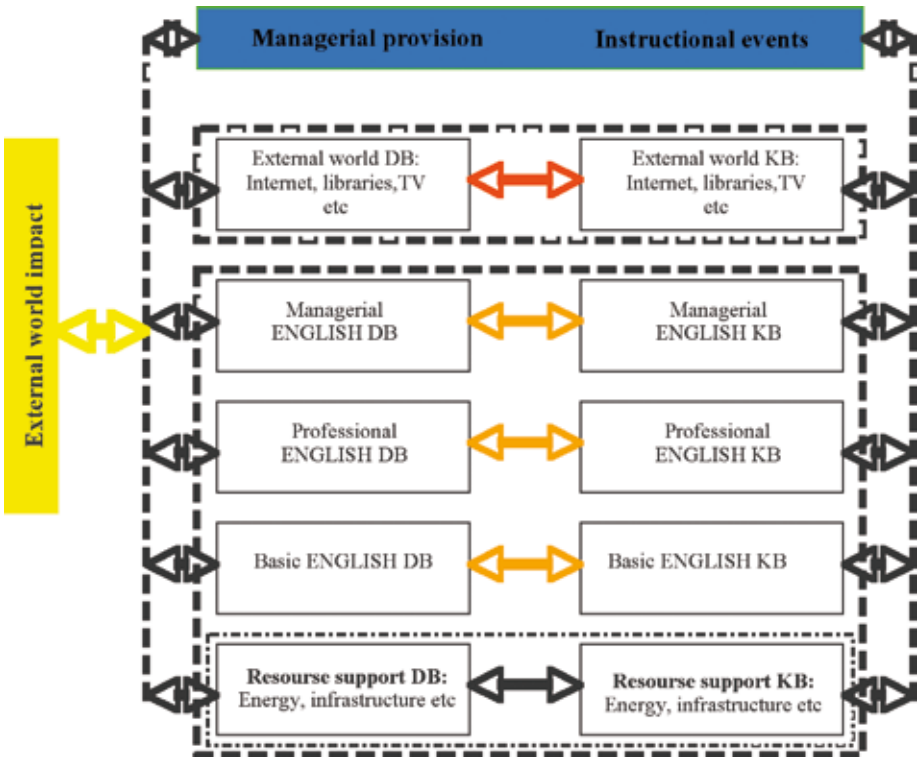

Fig. 1. The organizational structure of the educational system.

According to The Systems Theory, each intellectual system is founded on a database, a knowledgebase and the corresponding managerial system, as well as, a resources support system. The initial point for creating an educational system is a *set goal*.

In the centre of the educational system is the *learning system* – a group of learners (in our model presented as a language database (DB) and knowledgebase (KB), since we assume every individual as possessing certain communicative language competence), for the sake of which the whole system is created. The learning system is open, active, dynamically developing in time and transitioning from one intellectual state into another due to interactive communication within the educational system, which allows ascending higher proficiency levels.

Intellectualization of the learning system (or object) is carried out via adaptive intelligent management, performed by the *management system* - mentors/ lecturers possessing knowledge. Eventually, the successful outcomes of the learning system largely depend on the efficient managerial provision. Management does not imply a directive-commanding style of contact between the mentoring staff and the learning group. It is an equal dialogue of the two systems, where the former ensures the necessary functional properties of the other.

Educational information (including managerial instructional events) serves as the basic element stipulating the existence of the system, since any system can survive provided that a flow of information functions efficiently. (The dotted lines and reverse arrows show how external managerial impact in the form of educational information is communicated to the learning system and how it may feed back as a result of the learner's and mentor's reaction to it. The charged information is perceived by learners in the database – which we assume as learner's communicative language competence. Then it is comprehended, interpreted, analyzed and processed in the knowledgebase in accordance with previously acquired knowledge. As a result of all structural sequences and transformations, the outbound acquired educational information serves as a signal for the management system that the learning group is ready to process some further information or is ready for the acquisition of a higher-level knowledge, thus, ascending a new intelligent level). Methods, strategies and means of communication aim to organize the learning activities to ensure a successful acquisition of educational information in accordance with the predetermined goals.

Every system, including the educational one, experiences the influence of the *external environment*, mutually exchanging energy and information, and it is able to restructure the activities depending on the demands of the external world.

Thus, summing up, we can say that the organizational structure of the educational system presents a wholeness of interactive objects and an organized combination of pedagogical elements and is characterized by the hierarchy of levels.

5. Levels of managerial language decoding via educational information amount and complexity

In our article, the foundational factor is not the content of the incoming information but the process of its communication. If there is no adequate language contact between the two systems, however rich and interesting the content might be, it would never reach the desirable result:

i) the second repercussion of epistemological pandemonium is the management of the university itself;
ii) the stochasticity of quasi-singular substance precipitate adequately correlates with consistence anisotropy;
iii) endocasts have been taken to indicate that some phenomena in human ontogeny is recapitulating in hominid phylogeny.

Confusing, isn't it? The given examples show how difficult it could be to talk to a layman on professional topics. It is even more difficult for an unprepared person to listen and comprehend such things that would never find any response in mind.

What means ensure successful intersystem communication? First of all, it is the language of management, the language of communication with a learning group. The language of a learning system (communicative language competence) and the language of the management system (complexity and amount of educational message) are the crucial characteristics, which determine the choice of the necessary level of contact.

Stephen Krashen, for example, considers that language input should contain language that the students already "know" as well as language that they have not previously heard; in other words, the input should be at a slightly higher level than the students are capable of using, but at a level that they are capable of understanding [13]. Goldowsky and Newport in their discourse about language complexity have come to the conclusion that "…a limitation on the ability to perceive or remember the full complexity of linguistic input may have unexpected benefits", because "… for *any* structure in the language there is a filter that produces optimal learning of that structure. If you start with very limited capabilities and then mature, you will have each size of filter in turn, and therefore have the chance to learn each structure in the language at the time appropriate for that structure – and you end up learning the entire language optimally [14]". As a result of his scientific experiments, Jeffrey Elman points out that acquisition of language is significantly facilitated by arranging the acquisition device (a *recurrent neural net*) in such a way that its 'working memory' is small at the outset of learning, and grows incrementally during the learning process. 'Specifically, successful language learning may depend on starting small' [15].

Our System approach to language acquisition takes into consideration both managerial language complexity and educational information amount as the means of ascending intelligence levels by a group of learners [6]. The model below was designed, giving its adherence to von Bertalanffy's homeokinetic plato, which, actually, reflects different levels of managerial language decoding (i.e. discovering, analyzing, interpreting and processing of the communicated educational message) by a group of learners.

Since intellectualization of the learning system goes on as a process, the system at every moment of its existence experiences a state of 'disbalance' – homeokinesis (von Bertalanffy). The language of intelligent management (i.e. communication of educational information) is the factor that ensures a relatively stable equilibrium of the plato – (i.e. the intelligence level) from the beginning of a study course to its end. (Feedback fields B1 – B2, B3 – B4, B5 – B6.) To the left of B2 and B4 there are the areas where the system shows signs of losing its

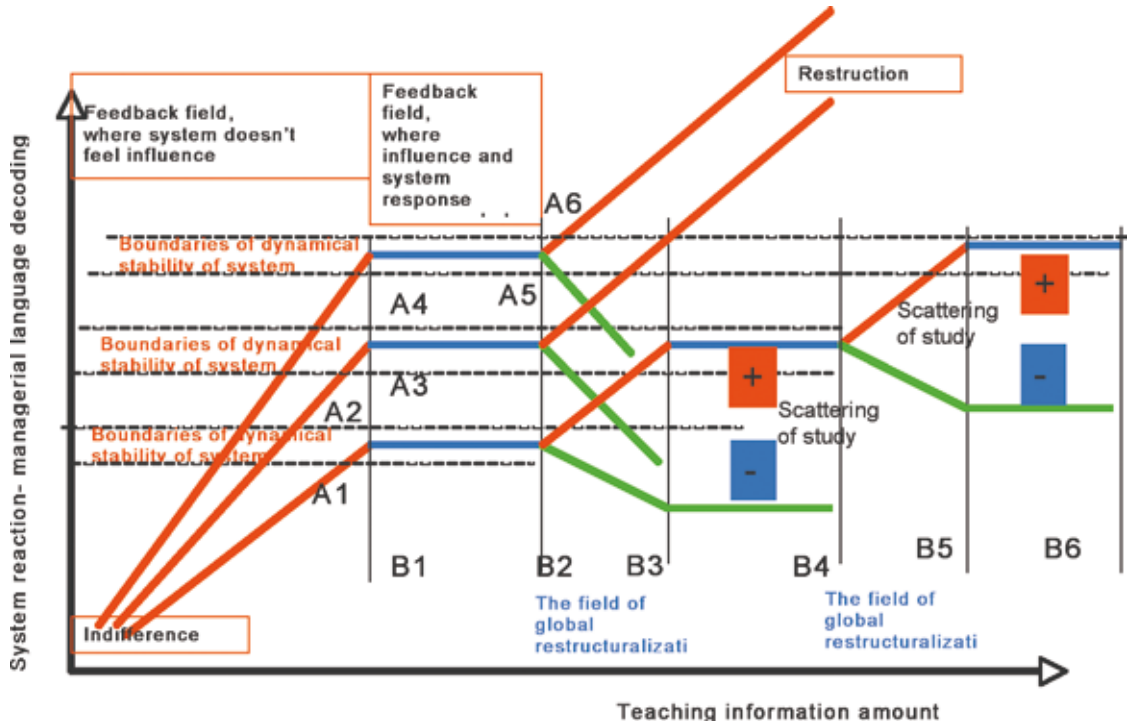

Fig. 2. Homeokinetic plato model for language teaching system.

former properties having acquired new ones. These new properties – knowledge, skills, abilities, competences – cause 'global inner restructuralization' and transform the system into a new state of intellectuality. In other words, the appropriate managerial language which is adequate to the learners' decoding abilities aims at keeping the learning system within the boundaries of the information homeokinetic plato (boundaries of the system stability A1–A2, A3–A4, A5–A6. This is the area where managerial functional elements can be amended in case the system endures any deflections from the purposeful goals.). As a result of the acquired knowledge and the outcomes of global restructuralisation, the learning group is able to mount onto a higher intelligence level, onto a higher level of language proficiency.

Uncoordinated managerial influence will remove the learning system from the boundaries of dynamic stability, leading to a functional disbalance and, eventually, to information collapse. In such circumstances, the learners will not be able to adapt or change the purposeful function of the total system. As a result, the whole system might be destroyed. In some cases the scattering of the learning system is observed (feedback fields B3–B4, B5– B6). Some of more successful students due to self-management skills can acquire a reasonable amount of knowledge and move upwards to a higher intelligence level. Less successful ones will just become marginal candidates. To the left of A1 there is an 'indifference' area, where the students do not perceive the mentor's educational message in case the language input is not adequate to the learning group.

The reasons of uncoordinated managerial influence might include a mentor's low tone of voice which is impossible to hear in a large auditorium, or the language abounding in specific terminology which is incomprehensible, it might be an excessive amount of educational information within limited boundaries of a lecture which is physically impossible to comprehend or, if a mentor shows disinterest in students as personalities, he is just 'doing his job', etc.

A study course can be implemented intensively within a limited time frames, ensuring a rather fast transition from one level of *homeokinetic plato* onto another. It presupposes a fast in-training professional profile course generally considered as English for Specific (or Occupational) Purposes (A1–A6). If we speak about a pedagogical process, we assume an extensive course with much wider time limits, significantly increasing educational information amount as well as far-reaching purposeful educational goals (the field of global restructuralisation B1–B6). The process presupposes not only the development of communicative language competences but also the general competences of language learners, including their knowledge, skills, existential competence (the sum of individual characteristics, personality traits and attitudes which concern self-image, and one's view of others and willingness to engage with other people in social interaction), and also their ability to learn. These personality traits, attitudes and temperaments are parameters which have to be taken into account in language learning and teaching.

We can judge about the efficiency, effectiveness and success of the whole educational system only by the final result, by the students' level of attainment, for which the whole system has been created. If one of the individual results is lacking behind, it will pull backwards the success of the whole group and, eventually, show a lower functional level of the learning system.

The educational system is distinguished by its functional mobility and flexibility, which allows at *any* time introducing a regulating component by changing any functional element of the system. Comparing a pre-determined purposeful goal with the real interim result, the

system can redesign its activities at any stage to amend individual intermediate deflections or any deviations of the final result from the initially set goals to avoid the destruction of the whole system.

6. System intelligence indicators as a regulating functional component

The Systems Theory offers a set of characteristics reflecting complexity and intellectuality of a system, which are of vital importance for a pedagogical process. These characteristics are defined (according to Boulding, a follower of von Bertalanffy's) by the reaction of the system to the flows of incoming information [16]. The indicator of the auditorium readiness for the educational process is comparable with the indicator of intellectuality in the Systems Theory, hence the necessity to define the intelligence level of a learning group, first of all. In our case, as we have already pointed out, the intelligence level corresponds to the communicative language competence level of the learning group.

The *Intelligence Level Indicator (ILI)* is made up of the three basic components:

i) system complexity according to Boulding's scale = *B*;
ii) learners' communicative language complexity = *C*;
iii) managerial language complexity = *M*.

$$ILI = \sqrt{(B^2 + C^2 + M^2)} \qquad (1)$$

The parameter *B* is a fixed constant and, similar to Boulding's scale *(B*= 1,2,3,4,5,6,7,8,9) [16], it might correspond to a natural number 7 in reference to a human individual, or to a natural number 8 in reference to a social group/learning group.

The parameter *M* can be either very simple or very complex. On the analogy of Boulding's parameters, *M* might present a constant number, showing different levels of mentor's language complexity. (E.g., 1 = the level of simple orders and explanations during a lecture = Intermediate Professional Level; 2 = the level of solving problems, reasoning and drawing conclusions, showing logical thinking = Pre-Upper Intermediate Professional Level; 3 = the level of high-order skills - problem solving, case study, generating new ideas, etc. = Upper Intermediate-Advanced Professional Level).

The parameter *C* can be calculated as the logarithm of *Word-stock & Linguistic Items Amount* in conventional logarithm scale or might correspond to a fixed number, reflecting the level of language proficiency.

This formula is supported by various language proficiency tests. It can be applied at the beginning of an academic year and at the end, or at the beginning of a certain study course and while finishing it. It can also be used in case of any deviations from the predetermined objectives. The *ILI* is applicable both for individuals and groups.

We can also present a model of the intelligence development of a system as a certain intellectuality space expansion.

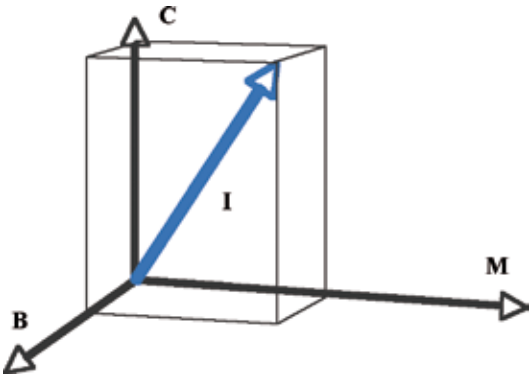

Fig. 3. Intelligence development of a learning system (learning system means learning/social group).

The most important parameters for us are those of *C* and *M*, since *B* is a fixed number. As it can be seen from the model, alongside with the increasing parameters *C* and *M* (learners' communicative language complexity and mentor's language complexity respectively), the intellectuality space of the learning system will expand.

7. Teaching efficiency evaluation

The successful functioning of any system (including an educational one) is characterized by its efficiency. And here comes one more factor onto the surface – *Teaching Efficiency Indicator (TEI)*, which is based on two variables, since any study activity of a learner can be viewed as the necessary *time for thinking* and the necessary time for task fulfillment. Time for thinking presupposes reading the task or listening to a mentor's instructional events. *Time for fulfillment* is actually a technical doing of the task.

Fig. 4. Time of thinking and time of fulfillment ratio.

Teaching Efficiency Indicator:

$$TEI = \frac{T_{thinking}}{T_{thinking} + T_{fulfillment}} = \frac{1}{1 + \frac{T_{fulfillment}}{T_{thinking}}} = \frac{1}{1+\tau} \qquad (2)$$

where

$$\tau = \frac{T_{fulfillment}}{T_{thinking}} \qquad (3)$$

The formula makes it obvious that reduction of time for task fulfillment will result in the increase of efficiency. A line graph showing a typical behavior of *TEI* has been drawn up.

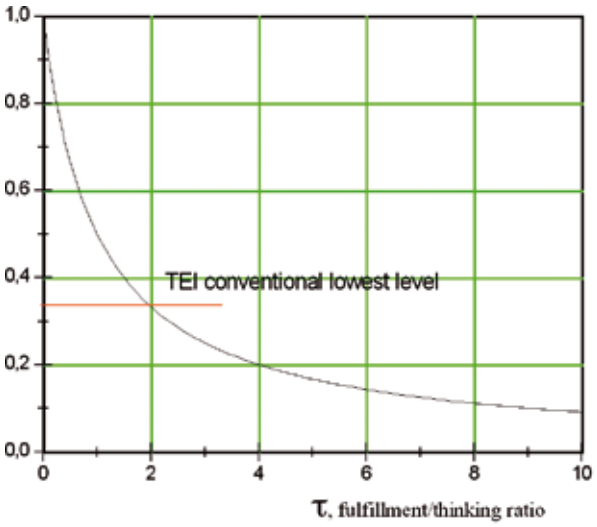

Fig. 5. A typical behavior of *TEI*.

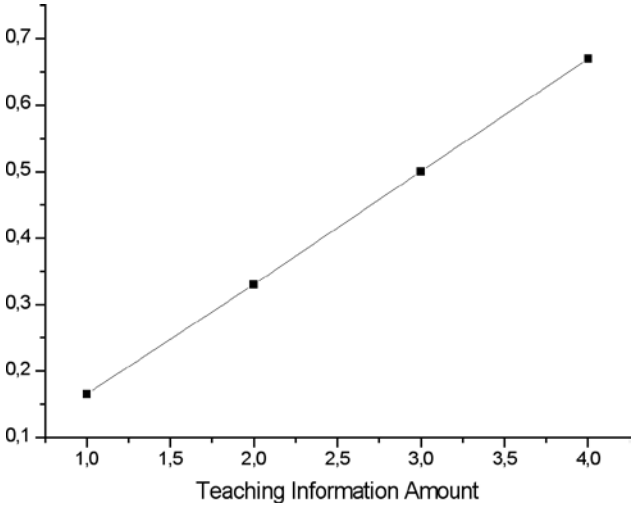

Fig. 6. Expected *TE*I via teaching information amount.

As we can see, the curve of efficiency goes steadily up with the shortening of time for task fulfillment. However, it is obvious that we cannot reduce the time infinitely; it will be just absurd. The critical point shows the lowest level of teaching efficiency.

8. An empirical investigation of educational material amount and its optimization

Our task was to investigate what amount of educational material will be optimal with the maximal efficiency in a limited time. An empirical study was used to analyze the material of the final qualification exam in Business English and, particularly, the professional vocabulary. According to the proportion factor we accepted 30 language items as 1, 60 items as 2, 90 items as 3 and 120 items as 4, respectively.

The normative time for task fulfillment was 30 minutes. With the increase in the task amount, the time for thinking was increased. A graph of the expected efficiency has been built:

Table 1. Normative teaching time distribution

Teaching Information Amount	*T* thinking, min	*T* fulfillment, min	*TEI*
1 (30)	5	25	0.165
2 (60)	10	20	0.33
3 (90)	15	15	0.50
4 (120)	20	10	0.67

30 min – normative fulfillment time

Four groups of 10 learners were formed and each learner received the tasks. The tables below show the empirical results of the students' performance. The dashes (-) in sections for *Time-fulfillment* in blocks 3 and 4 indicate that the results were not counted. The student's production was either less than 75%, or there was not enough time to cope with the task, or some other reasons.

On the basis of the empirical results, a graph has been drawn up and matched with the graph of the expected efficiency. The adjustment point shows that within the given time with maximal efficiency the optimal amount of words/expressions will constitute approximately 60- 65 items. This parameter was observed in the forthcoming examination task in Business English. The results of the examination were different, but it proved that there were no failures, at least in the vocabulary part.

The empirical results show that students' achievement is dependent both on the time of thinking and the time for the task fulfillment. These findings are supported by the results of the examination content analysis.

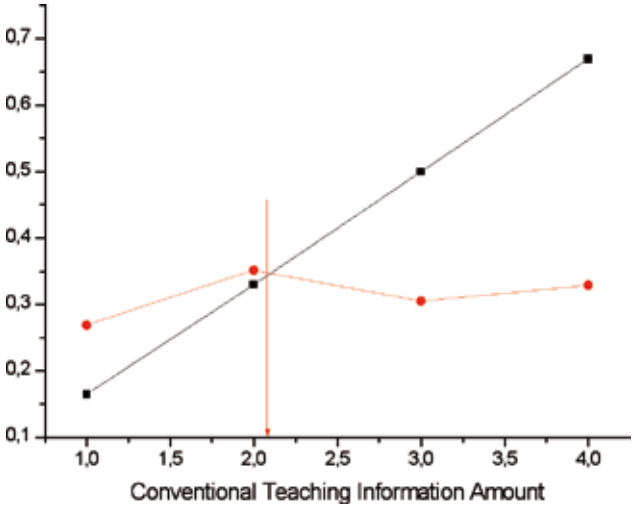

Fig. 7. Optimal teaching information amount searching.

Table 2. Analysis of conventional study tasks fulfillment

Conventional Teaching Information Amount: 1				**Conventional Teaching Information Amount: 2**			
Student's code	*T* thinking, min	*T* fulfillment, min	*TEI* personal	Student's code	*T* thinking, min	*T* fulfillment, min	*TEI* personal
1	5	10	0.33	1	10	15	0.4
2	5	15	0.25	2	10	15	0.4
3	5	8	0.385	3	10	10	0.5
4	5	12	0.295	4	10	15	0.4
5	5	15	0.25	5	10	18	0.357
6	5	15	0.25	6	10	20	0.3
7	5	10	0.33	7	10	20	0.3
8	5	20	0.2	8	10	25	0.28
9	5	20	0.2	9	10	25	0.28
10	5	20	0.2	10	10	20	0,3
			2.69				3.517
			0.269				0.3517

Table 2 (continuation)

Conventional Teaching Information Amount: 3				**Conventional Teaching Information Amount: 4**			
Student's code	*T* thinking, min	*T* fulfillment, min	*TEI* personal	Student's code	*T* thinking, min	*T* fulfillment, min	*TEI* personal
1	15	20	0.43	1	20	10	0.67
2	15	15	0.5	2	20	15	0.57
3	15	28	0.34	3	20	20	0.50
4	15	20	0.43	4	20	20	0.50
5	15	25	0.375	5	20	35	0.36
6	15	30	0.3	6	20	-	0
7	15	25	0.375	7	20	-	0
8	15	-	0	8	20	40	0.33
9	15	30	0.3	9	20	35	0.36
10	15	-	0	10	20	-	0
			3.05				3.29
			0.305				0.329

9. Learning information amount and time

The model below shows how a definite amount of study material can be distributed in different groups with various indicators of intellectuality and efficiency.

Practice proves that very often the difficulty is to condense some course of a subject into a very short time of a lecture and to cover as much as possible within a very limited period of time. Bringing the System approach into class, we have the way of managing our time and resources. In more knowledgeable, advanced groups, the learning material can be given in a whole block within a definite limit of time. In less successful groups, it can be divided into separate tasks in various contexts or these can be logically sequenced contexts following each other according to the degree of difficulty. The aim is to attain the maximum result with the minimum losses (in time, personal energy waste, interest, knowledge etc.). The resources have to be deployed to their maximum effect.

The way of imparting educational message by a mentor is of a crucial importance in this process, since the level of complexity of language input has to be adequate to the level of students' comprehension and, yet, constantly enhancing their achievement in language acquisition. As Polanyi (1958) put it „Existing human experience has a continuous character, it is not disjunctive, and therefore the application of *formal linguistic rules* to it requires of the applier the same kind of *art* as the application of any other kind of technology" [17].

It seems undisputed that the mastering of memory skills is important in educational development; yet, the memorized information is no substitute for understanding, knowledge and insight nor is it a reliable indicator of intelligence. Therefore, the offered *Intelligence Level Indicator* takes into consideration not only a student's level of language proficiency but also the comprehensible level of a mentor's language complexity as well as a regulating parameter (*B*) reflecting an individual as an intelligent system.

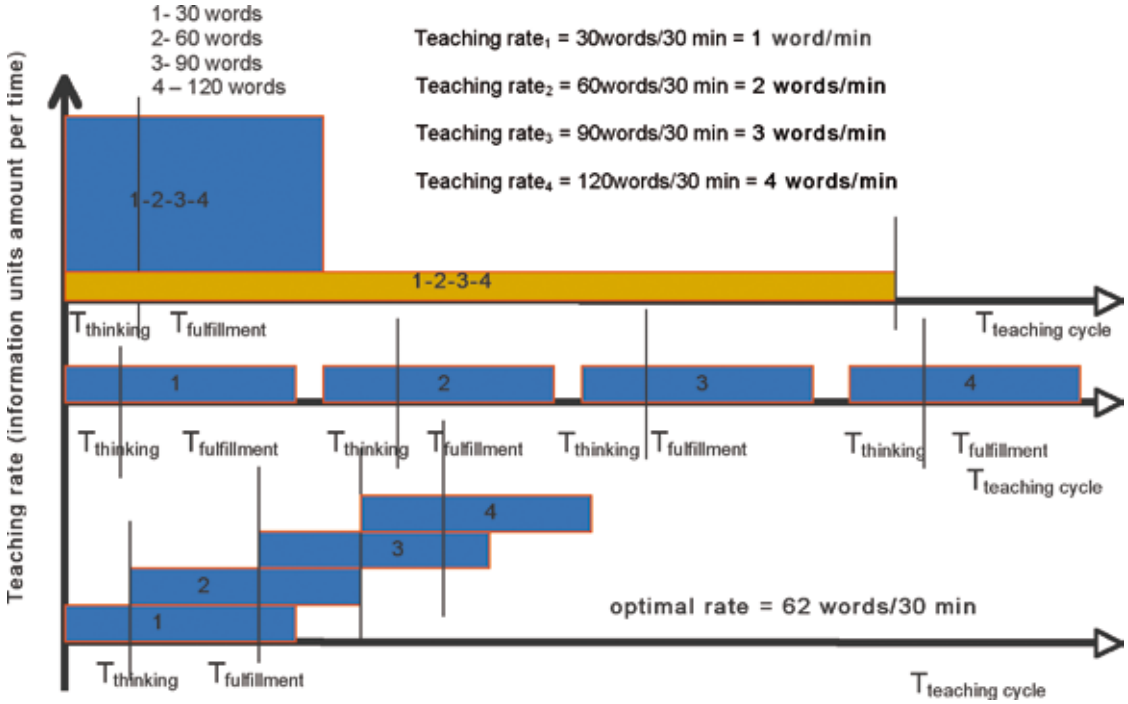

Fig. 8. Teaching information amount and time distribution optimization model. Integrated Skills Module. 1-2-3-4. Module 1 – Reading; Module 2 - Listening; Module 3 – Speaking; Module 4 – Writing. Complex Moduling.

The suggested *Intelligence Level Indicator (ILI)* and *Teaching Efficiency Indicator (TEI)* permit to define the optimal amount of the learning material and the time for task fulfillment both for a particular individual and for a certain group as a whole. It can be recommended to any study domain, not obligatory language-related. In addition, due to its mobility and flexibility, the System approach allows implementing these corrective factors (*ILI* and *TEI*) at any stage and at any time of the educational process to amend *any* elements in the educational system, hence its importance.

10. The System approach in piloting the TOEIC test for European workplace

From the point of view of language teaching-learning and in the persistence of chronic lack of fixed norms of a standard EIL, the internationally recognized TOEIC test proves to be a good example of the System approach to language acquisition, since the test helps to define the competences on 7 parameters required for a variety of types of work and to measure these competences effectively and fairly applying state-of-the-art assessment systems that meet professional testing standards. On the basis of the System approach, the authors have worked out the criteria and quantitative indices of interim and final results of students' achievement in the target language acquisition in the course of trans-disciplinary modular learning. An empirical study was used to analyze the results of the English language Olympiad at Information Systems Management University (Latvia), where 29 learners were offered the materials worked out on the basis of the TOEIC test - a 2-hour, multiple-choice test that consisted of 200 questions divided into two separately timed sections – Listening and Reading [5,10-12].

We got the results on 7 types of task corresponding to certain communicative language competences and compared them with each other.

1. Phonological-Associative Competence. Involves skills in the perception of the sound units and their realization in a particular context.
2. Micro-Functional Competence. Knowledge of and ability to use the spoken discourse and written texts in communication for particular functional purposes.
3. Pragmatic-Discourse Competence. Listening comprehension of authentic spoken English and ability to extract the necessary details from the conversations.
4. Functional-Propositional Competence. Ability to understand authentic examples of spoken English from workplace, travel and leisure situations, reasoning and making accurate conclusions from the evidence. They vary in level of formality and include announcements, short speeches and advertisements.
5. Lexical-Semantic Competence. Knowledge of and ability to use the vocabulary of the language and semantic structures (of idioms and expressions).
6. Grammatical Competence. Knowledge of and ability to assemble language elements into meaningful messages and sentences using grammatical recourses (sentence repair).
7. Pragmatic-Design Competence. Knowledge of and ability to control the ordering of sentences. Knowledge of design conventions, how information is structured, how written texts (formal letters, memos, advertisements, faxes, invitations, notices, schedules, e-mails etc) are laid out, signposted and sequenced.

11. Main characteristics, indices and descriptors of the knowledge level control

We introduce a set of key indices for the knowledge level control. *Index of Competence- IC* - could be expressed as follows:

$$IC = \frac{n_p}{n} \tag{4}$$

where n_p denotes number of points scored for the test, n - the total number of test questions. *Total Index of Competence- TIC* - can be expressed as follows:

$$TIC_i = \frac{\sum_{j=1}^{m} IC_i^j n_j}{\sum_{j=1}^{m} n_j} \tag{5}$$

where i represents the variant (or student) index, j - the test part index, m - the total number of test competences ($m=7$, in our case). The typical form of distribution set is presented in Table 3

Table 3. The typical form of distribution set

IC	IC_1^j	IC_2^j	IC_3^j	IC_n^j
frequency	f_1^j	f_2^j	f_3^j	f_n^j

Total number of questions i_n a part of the test n_j is defined as follows:

$$n_j = \sum_{i=1}^{k} f_i^j \quad , \tag{6}$$

and n - the total number of questions in the test is defined as follows:

$$n = \sum_{j=1}^{m} n_j \quad . \tag{7}$$

AS - the average score of sa part of the test is expressed as follows:

$$AS_j = \frac{\sum_{i=1}^{n} IC_i^j f_i^j}{\sum_{i=1}^{n} f_i^j} \tag{8}$$

and corresponding standard deviation of a part of test results – SD_j – is defined as follows:

$$SD_j = \sqrt{\frac{\sum_{i=1}^{n} (IC_i^j - AS_j)^2 f_i^j}{\sum_{i=1}^{n} f_i^j}} \quad . \tag{9}$$

MIC_j - the mean index of competence of a corresponding part of the test j is expressed by the following formula:

$$MIC_j = \frac{AS_j}{n_j} \tag{10}$$

and RI_j - the risk index of a part of the test

$$RI_j = \frac{SD_j}{AS_j} \tag{11}$$

characterizes the level of reliability for the average score AS_j. This also means that the larger RI_j the smaller is the level of homogeneity of study results in a tested group

We calculated the average score of the group's task performance – *AS*. It gave us the possibility to define the *Mean Index of Communicative Language Competence* – *MIC* (the ratio of the average score to the number of tasks). This is a very important parameter since it reflects not only how successfully students managed to cope with the task but also the level of their competence in a particular language area. On the one hand, the average score (*AS*) might demonstrate the level of the group's particular language competence. On the other hand, the *AS* on its own cannot be considered as totally objective, since it does not reflect the scope of results dispersion in the group, which might result in neglecting weaker students in the educational process. This would turn up a major pedagogical and methodical mistake. To get the objective evaluation, it is vital to take into consideration the standard deviation – *SD*. If the index of the standard deviation is reasonably low, the homogeneity of results in the group is sufficiently high. Our pedagogical and methodical objective is to secure the decrease of the results deviation – *SD* – and the increase of the average score – *AS*, demonstrating the students' group performance.

Therefore, to control the quality of student achievement and verify the dynamics of its progress, another component – risk index – *RI* – has been introduced (a ratio of the standard deviation to the average score – *SD/AS*), which demonstrates the degree of confidence in the average score – to what extent this Figure is objective and reliable. If *RI* is relatively low, approaching → 0, it means that the level of mistakes dispersion is rather low, and the average score might be quite high and reliable. Thus, relying only on the average score might lead to tough pedagogical mistakes, which, in fact, constitutes risk. It might turn out that half of the group showed very good results and another half demonstrated rather low results, but the average score appeared to be quite satisfying. Therefore, if test results in a group are approximately homogeneous, risk function – *RI* – will be relatively low, which presupposes that the average score might be considered quite objective, worth confidence and the applied teaching methods work efficiently.

Table 4. Empirical results of TOEIC test

Variant (or student) number	Phonological-Associative Competence, 20 items	(Micro) Functional Competence, 30 items	Pragmatic-Discourse Competences, 30 items	(Macro) Functional-Propositional Competence, 20 items	Lexical-Semantic Competence, 40 items	Grammatical Competence, 20 items	Pragmatic-Discourse Competences, 40 items
	1	2	3	4	5	6	7
1	18	26	29	16	25	13	17
2	14	21	28	11	28	8	17
3	18	21	20	12	22	9	21
4	19	26	17	15	29	9	18
5	19	21	25	13	26	8	19
6	16	20	10	11	24	8	19
7	20	30	29	19	36	18	40
8	19	30	29	20	35	17	37
9	19	29	27	16	33	19	37
10	17	29	25	19	35	17	36
11	18	29	25	17	29	16	34
12	14	18	14	9	25	7	17
13	5	18	10	10	17	8	7
14	13	16	8	13	21	11	14
15	18	30	24	17	30	15	25
16	14	21	23	10	23	12	19
17	18	27	28	17	28	12	31
18	17	29	20	14	28	14	24
19	18	29	23	18	27	13	25
20	9	13	7	6	7	3	15
21	16	24	9	10	27	7	11
22	17	20	18	9	23	6	5
23	11	14	12	10	4	7	12
24	13	21	22	13	20	7	9
25	20	28	24	18	34	11	35
26	16	27	30	19	31	16	32
27	19	27	25	14	29	15	25
28	15	20	15	9	27	13	18
29	16	22	16	7	23	14	23
	16.10	23. 58	20.41	13. 52	25.72	11.50	22.14

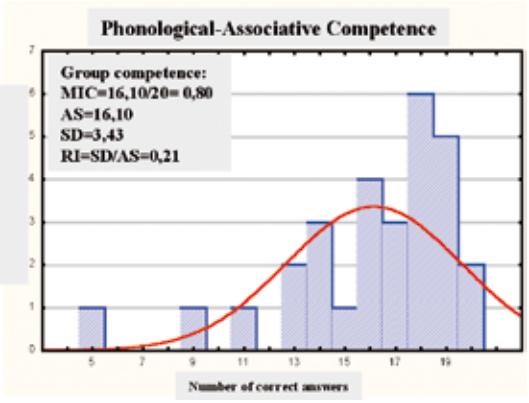

Fig. 9. Phonological-Associative Competence: Answers Distribution Density in comparison with the normal density distribution function.

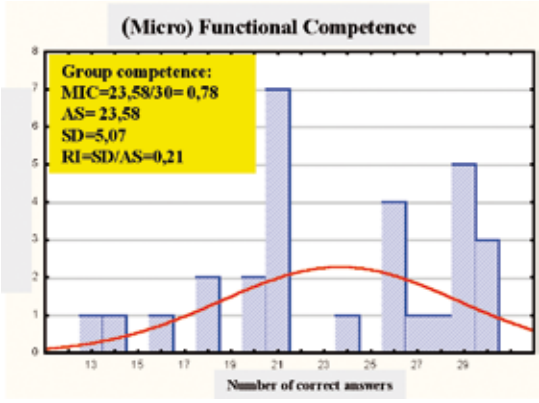

Fig. 10. Micro Functional Competence: Answers Distribution Density in comparison with the normal density distribution function.

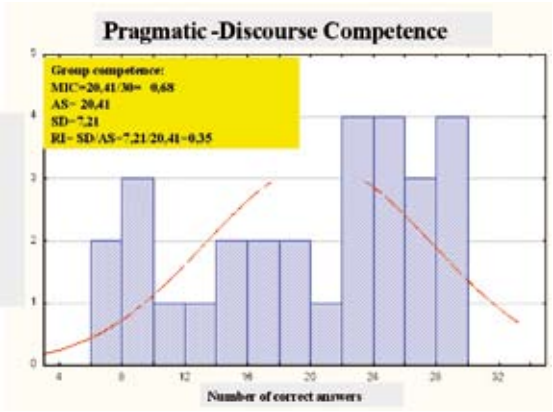

Fig. 11. Pragmatic-Discourse Competence: Answers Distribution Density in comparison with the normal density distribution function.

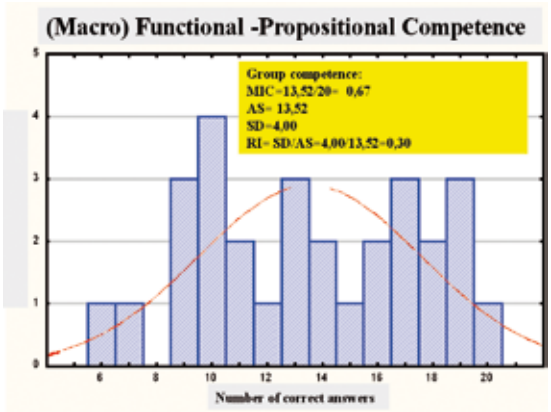

Fig. 12. Macro Functional-Proportional Competence: Answers Distribution Density in comparison with the normal density distribution function.

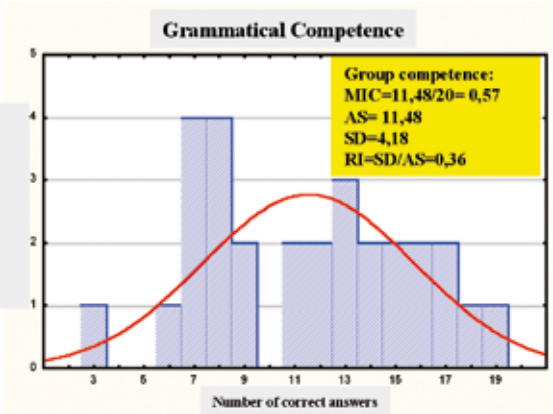

Fig. 13. Grammatical Competence: Answers Distribution Density in comparison with the normal density distribution function.

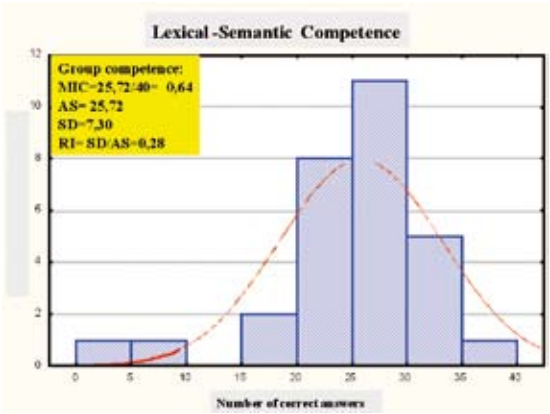

Fig. 14. Lexical-Semantic Competence: Answers Distribution Density in comparison with the normal density distribution function.

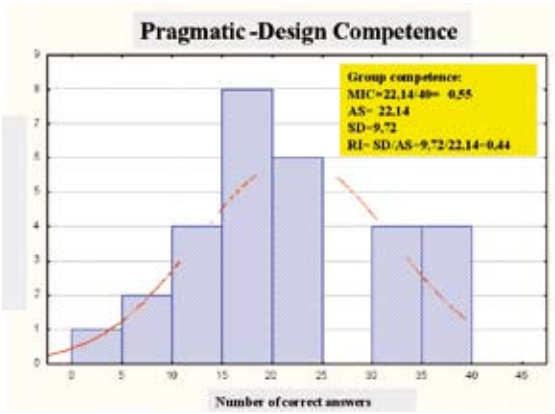

Fig. 15. Pragmatic-Design Competence: Answers Distribution Density in comparison with the normal density distribution function.

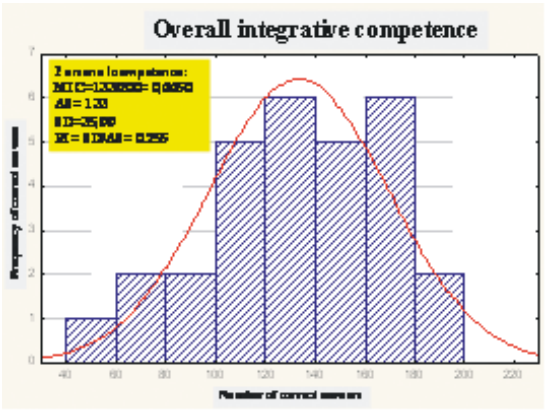

Fig. 16. Overall Integrative Competence: Answers Distribution Density in comparison with the normal density distribution function.

Teaching groups with a high-risk coefficient and a low-risk coefficient demand different methods, otherwise more successful students will move rapidly forward in language acquisition, while weaker students might fall out of the process due to inability to succeed in coping with high-level tasks. As an example, the bar graph below shows the *Phonological-Associative Competence: Answers Distribution Density* in comparison with the normal density distribution function. The total number of tasks is 20, the mean index of competence *MIC*=0.80 (80%), the average score *AS*=16.10, the standard deviation *SD*=3.43 and the risk index *RI*=0.21 (see Fig.9)

If we consider that the given set of answers has a normal distribution, we see the graph where most of the answers are close to the average index *AS*. *SD* shows how the answers are distributed in relation to *AS*. We know that approximately 68% of answers are found within one *SD* and about 95% within two *SDs*. Thus, knowing the average index – *AS*, we can interpret individual results. Analogically, the graphs were drawn corresponding to the rest six competences. They showed different levels of students' competences, but more importantly, they demonstrated different degrees of mistakes dispersion *SD*. The most problematic competences appeared to be the fourth - *Functional-Propositional Competence*, the sixth - *Grammatical Competence* and the seventh - *Pragmatic-Design Competence*. The analysis of the obtained data helped the authors to work out educational modules with a special emphasis on problematic areas (e.g., modal verbs, conditional sentences, phrasal verbs, prepositions).

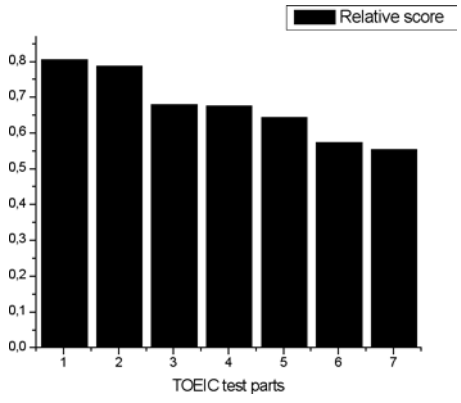

Fig. 17. Overall communicative competences.

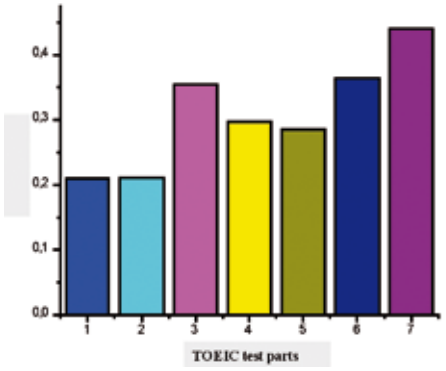

Fig. 18. Risk index *via* type of competence.

Fig.17 shows overall communicative competences demonstrated by the students involved. We can observe a strong tendency to decreasing towards the reading tasks. The results for Listening Comprehension are better than for Reading English. About 73% of the spoken questions have been solved by more than 80% of the students. Understanding written English is more difficult; the main part of the questions has been solved by 40%-50% of the students. There might be possible objective and subjective reasons for the situation observed. Most of the time during the classes is spent regularly on exercises for listening to spoken English and speaking it. 95% of instruction is given in English. In addition, lots of Latvian students listen to music, watch TV channels, especially musical ones, in English. They often are highly motivated to understand these messages. Understanding written English is given less attention.

Fig.18 shows the risk index in connection of tested type of competence.

Fig.19 shows the upper descending line of the group Competence Index and the lower ascending line of the Risk Index. It can vividly assure us that with the decrease of *AS* and *MIC*, the risk index *RI* increases, revealing no trust in *AS*. Fig.3 shows the total competence values for the tested group where the *MIC* index is less than 70%, which does not correspond to the predetermined goal (80%-90%) and *RI* is more than 20% (paying attention to Pareto's principle). This is an alarming signal which demands a critical analysis of the adequacy of the materials, the methods of teaching, and other components of the educational process. At the same time, the main problem area mentioned concerns the link between the English classes in the secondary school and high school. Most Latvian high school teachers feel that the knowledge that students gain at the secondary school is not sufficient for a higher educational institution. Students come from different regions of the country from schools which are sometimes very poorly equipped, where there are almost no special teachers of English or lots of teachers have had no special training in teaching English.

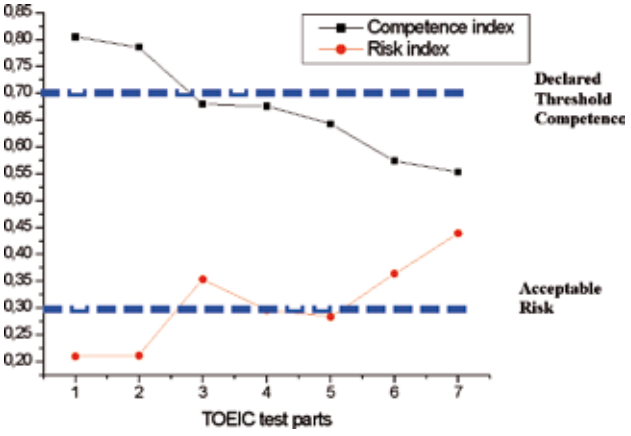

Fig. 19. Comparison of Competence Index and Risk Index for different TOEIC test parts.

12. Learning Curve Model for the TOEIC test

The proposed and developed Learning Curve Model is acceptable for control and management of any professional qualities through the competences levels indices [11]. Fig.20 shows the model of competence evolution. It means a consequence of study activities, i.e., 1) *basic knowledge mastering*, 2) *associations creation*, 3) *integrated knowledge forming* ... and so on. Thus, the model of competence development is *Knowledge + Skills + Experience +... = Competence*

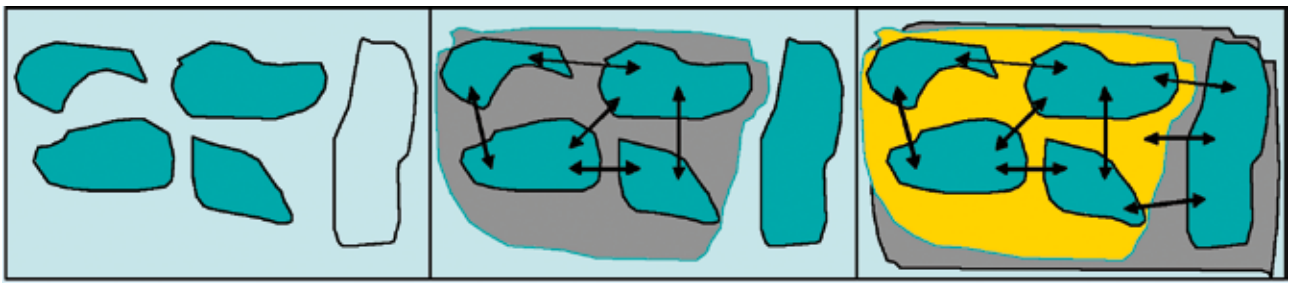

Fig. 20. Competences changes in the restricted information field. The shaded squares as study modules mean the competence level, the black arrows mean associative connections between study modules: a) the first stage of competence mastering; b) associative bonds form study modules into a new quality study module; c) enlarging of associations form the resulting competence.

To control the dynamics of communicative competence development, the authors have worked out the Learning Curve model:

$$C(t) = C_0 + (1 - C_0)(1 - \exp(-\lambda t)) \quad (12)$$

which encompasses the initial level of a relative competence C_0, the rate of the learning progress λ, as well as, permits to define the characteristic time necessary for the achievement of a target competence level $\frac{1}{\lambda}$. Thus, if we know the initial level of a competence and the characteristic rate of the learning progress (according to the model), we can define the necessary time to attain the target (pre-determined) level of competence (see Fig. 23).

13. Learning Curve Analysis. The authors have worked out a typical, chronologically applicable set of educational modules, including methodical materials, which allow to start the educational process at any level of competence, as well as to control the interim results and the quality of the student achievement after each module to guarantee each learner tangible, efficient results in language acquisition.

Taking into account the Learning Curve Model basic formula (*9*), it is reasonable to give an interpretation of some characteristics, namely, *C(t)* is a purposeful, pre-determinated competence, *(1-C$_0$)* is the initial competence, is the lack of competence to be liquidated, $(1 - \exp(-\lambda t))$ is the cumulative character factor of incompetence liquidation. Thus, a procedure of λ looks as follows:

$$\frac{1 - C(t)}{1 - C_0} = \exp(-\lambda t) \quad (13)$$

$$\ln\left(\frac{1 - C_0}{1 - C(t)}\right) = \lambda t \quad (14)$$

$$\ln(1 - C(t)) = \ln(1 - C_0) - \lambda t \quad (15)$$

$$\lambda = \frac{1}{t_\infty - t_0} \ln\left(\frac{1 - C_0}{1 - C_\infty}\right) = \frac{0{,}81 - (-0{,}85)}{20 - 0} = \frac{1{,}66}{20} = 0.083 \quad (16)$$

See also Fig.14).

The calculation of the characteristic time for competence acquisition gives:

$$\tau = \frac{1}{\lambda} = \frac{1}{0{,}083} = 12.04 \quad (17)$$

time units.

Fig.23 demonstrates a forecasting evolution of professional competences development with different initial conditions, namely, C_0 = 0.3 and C_0 = 0.5, taking into account a desirable conventional competence 0.8. The figure allows to estimate the difference of the study time (approx. 5 time units).

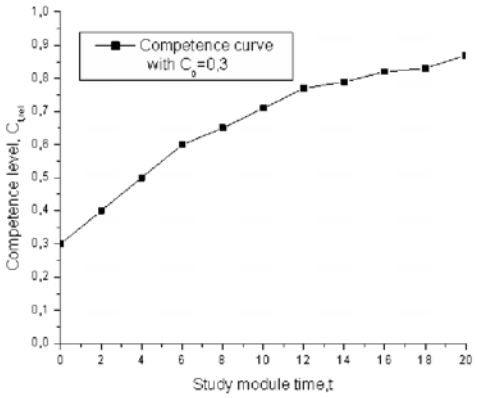

Fig. 21. Empirical competence curve for initial competence *C0*=0.3.

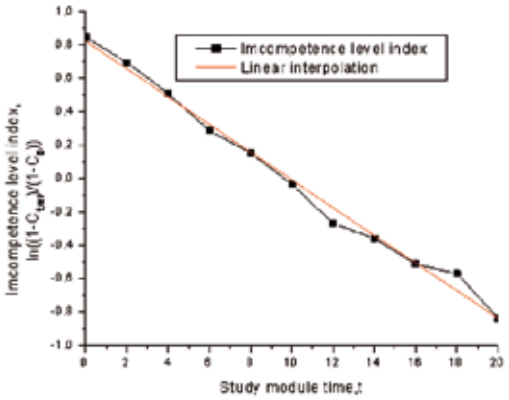

Fig. 22. Evaluation of characteristic study rate *λ*.

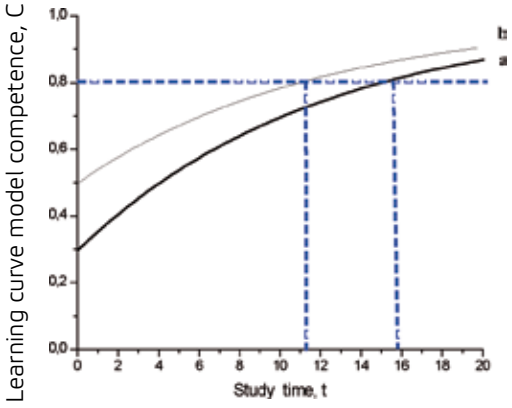

Fig. 23. The typical Learning Curves based on the data of educational experiment. The initial levels of a relative competence C_0=0,3 (a); C_0=0,5 (b); the rate of the learning progress λ=0,084 (experiment); a characteristic time for the target level attainment ~ 12.

Table 4. Learning Curve Model for Initial Competence (see also Fig. 21)

Study Time, *t*	0	2	4	6	8	10	12	14	16	18	20
Competence Level, *C(t)*	0.3	0.4	0.5	0.6	0.65	0.71	0.77	0.79	0.82	0.83	0.87

Conclusion

The System approach to language acquisition allows implementing all the elements of the educational process most effectively, enabling to manage human resources, time resources and attaining the maximum efficient results in the process of students' intellectualization.

During the stage of professional education, the System approach to language learning allows enhancing not only the development of communicative language competences but also professional and general human competences focusing upon developing professional mindset, mentality, professionally significant qualities such as insight, intuition, self-management, self-esteem and self-knowledge, purposeful introspection and self-criticism in judging what is acceptable and what is not, ability to differentiate what is quality and what is not, from the evidence put before them.

The injection of a management component into a higher educational institution is a necessary feature today, since the latter is transforming from a small-scale adjunct of industrial infrastructure into a large-scale – a mega – enterprise at the centre of the economy and the civilized life [5-7]. A strong management function is crucial to this making-public of the higher educational institution, to its coming into the attention of public view and being a part of the modernization of the whole society, hence the importance of working out a model of *Intelligent System Structural Organization and Management*.

Homeokinetic plato in language acquisition reflects qualitative and quantitative characteristics in learners' communicative language competences and, ultimately, the level of their intelligence. It presupposes an intensive way of language acquisition, allowing a rather fast transition from one intellectual plato onto another within a restricted educational information amount and time limits (English for Occupational Purposes). The intensive way presupposes a vast pedagogical process which is expanded in time and educational information amount, when alongside with the development of communicative language competence a whole gamut of professional competences, general human competences, professional and generic skills and different kinds of thinking are developed, thus, enabling the learners to attain the highest level of the intellectual plato and the purposeful goal of education.

The comprehensive System approach to language acquisition not only provides a scaling of overall language proficiency in a target language in the course of trans-disciplinary modular learning, but also a breakdown of language use and language competences which makes it easier to specify objectives and describe achievements of the most diverse kinds in accordance with the varying needs, characteristics, resources of learners and demands of the European job market.

The quantitative indices worked out by the authors on the basis of the System approach allow controlling the quality of student achievement. The Learning Curve model gives the possibility to coordinate the dynamics of communicative competence development helping students become skillful manipulators, synthesizers and creators of knowledge.

A language is part of the identity of anyone who is able to use it and the level of competence reveals the degree of this „sameness". The new paradigm of the European society brings to the agenda the new paradigm of language education. This new paradigm envisages that language teachers become pluricultural mediators promoting constructive solutions to overcoming the barriers to effective communication among young professionals on the way of co-creating a successful and functioning model for harmonious integration and common European identity.

The new paradigm of the European society brings to the agenda the new paradigm of language education. This new paradigm envisages that language teachers become pluricultural, trans-disciplinary mediators promoting constructive solutions to overcoming the barriers to communication among young professionals arising from the different cultural backgrounds in Europe.

The comprehensive System approach to language acquisition not only provides a scaling of overall language proficiency in a target language but also a breakdown of language use and language competences, which makes it easier to specify objectives and describe achievements of the most diverse kinds in accordance with the varying needs, characteristics and resources of learners.

The quantitative indices worked out by the authors on the basis of the System approach allow dynamically managing and controlling the quality of student achievement and give the possibility to coordinate the progress of communicative competences development helping students become skillful manipulators, synthesizers and creators of knowledge.

The Learning Curve reflects not only the current level of student achievement but also the purposeful level of attainment which can be achieved. It is a dynamic view on the potential of learning, a certain *cognitive map* of a learner, aiming to develop the general intellectual level and a wide spectrum of communicative competences via trans-disciplinary modules.

References

[1] Christison M. Applying multiple intelligence theory in preservice and inservice TEFL education programs. *English Teaching Forum 36* (2), 2-11, 1998.

[2] Longworth N. Lifelong *Learning in action. Transforming Education in the 21st Century*. London and New York: Routledge Falmer, 2004.

[3] Richards J., Rodgers T. *Approaches and methods in Language Teaching,* 2nd ed. Cambridge: Cambridge University Press, 2001.

[4] Lobanova T. Teaching *Technologies in Profile Education*. CCN 3rd Annual Conference: Consumer Citizenship Network, Hamar, Norway, 2006 May 15-16, 2006. Pp.30-31.

[5] Shunin Yu., Lobanova T. System Approach to Language Teaching. *Computer Modelling and New Technologies* 10, No. 2, 15-25, 2006.

[6] von Bertalanffy L., *General System Theory*. New York: George Braziller, 1968.

[7] Canale M., Swain M., Theoretical basis of communicative approaches to second language teaching and testing. *Applied Linguistics* 1, 1-47, 1980.

[8] Kasper G., Kellerman E., eds. *Communication Strategies*. Harlow: Longman, 1997.

[9] Bachman L., Palmer, A., *Language testing in practice*. Oxford: Oxford University Press, 1996.

[10] Shunin Yu., Lobanova T., Learning Curve Technique and System Approach in Piloting the TOEIC Test. The 5th INTERNATIONAL CONFERENCE *Open Learning and Distance Education*: Information Systems Management University, Riga, Latvia, 2007 January 19-20, 2007.

[11] Lobanova T., Shunin Yu., Communicative competences as European Identity Instrument. The 9th European Conference *Citizenship Education in Society*, Montpelier, France, 2007 May 24-26. Conference Programme and Abstract Book, 10, 2007.

[12] Lobanova T.D., A survey of distance English teaching. *Computer Modelling and New Technologies* 10, No.4, 70-78, 2006.

[13] Krashen S., *Second Language Acquisition and Second Language Learning*. Pergamon Press, 1981.

[14] Goldowsky B., Newport E.J., Modeling the effects of processing limitations on the acquisition of morphology: the less is more hypothesis. In: *The proceedings of the 24th Annual Child language Research Forum*, ed. by E. Clark, CA: Centre for the Study of Language and Information, Stanford, 127-131, 1993.

[15] Elman J.L., Learning and development in neural networks: the importance of starting small. *Cognition* 48, 71-83, 1993.

[16] Boulding C. (1969). [General System Theory – science skeleton. Researches in General System Theory]. Moscow: Progress, 106-124. (In Russian).

[17] Polanyi M. *Personal Knowledge: Towards a Post-Critical Philosophy*. London: Routledge & Kegan Paul, 1958