The Behavioural Motivation Model in Open Distance Learning

Oleg Zaikin
Warsaw School of Computer Science
WWSI
Warsaw, Poland
e-mail: ozaikin@poczta.wwsi.edu.pl

Magdalena Malinowska
Faculty of Management and Economics of Services,
University of Szczecin,
Szczecin, Poland,
e-mail: magdalena.malinowska@wzieu.pl

Lise Busk Kofoed
Department of Architecture, Design & Media Technology,
Aalborg University,
Aalborg, Denmark
e-mail: lk@create.aau.dk

Ryszard Tadeusiewicz
Department of Automatics and Biomedical Engineering
AGH – University of Science and Technology,
Cracow, Poland,
e-mail: rtad@agh.edu.pl

Andrzej Żyławski
Warsaw School of Computer Science,
WWSI,
Warsaw, Poland
e-mail: andrzej.zylawski@wwsi.edu.pl

***Abstract*—The article contains the concept of developing a motivation model aimed at supporting activity of both students and teachers in the process of implementing and using an open and distance learning system. Proposed motivation model is focused on the task of filling the knowledge repository with high quality didactic material. Open and distance learning system assures a computer space for the teaching/learning process in open environment. The structure of the motivation model and formal assumptions are described. Additionally, there is presented a structure of the linguistic database, helping the teacher to assess the student's motivation and the basic simulation model to analysis the teaching/learning process constrains. The proposed approach is based on the games theory and simulation approach.**

Keywords-motivation model; computer learning platform; knowledge repository; non-cooperative game.

I. INTRODUCTION

Open and Distance Learning Systems can be considered as a new stage of information system evolution in the distance learning domain [1]. Basic concept comes from Open and Distance Learning (ODL), which is an idea of the learning/teaching process organization in higher education institutions [2]. The “distance” aspect describes an educational situation, where the student is situated in a different place than the source of knowledge and the other participants of the teaching/learning process. All the communication and socialization is maintained by the information system. The “open” aspect of ODL is visible at many levels: social, technical, computer and organizational [3].

Implementation of Open and Distance Learning Systems [4] will most probably introduce changes to the entire organization of the education process at higher education institutions, and consequently – changes in the role and relationship between all participants of the learning process while still maintaining status-quo regarding the traditional mission of a university: preparing highly-qualified staff.

In traditional education, the level of competence a student obtained at a university depended on various factors [5], the main of which are: education process organization at all levels (starting from the curriculum, syllabuses, up to the classes themselves), equipment, ergonomic conditions, and most importantly – the staff qualification. The position of each university among others is decided on the basis of a ranking [6] that considers basic activities of each teacher and the university as a whole: didactic, research, and educational.

ODL can be considered as a new teaching technology, it is as good as well it expands everyone’s possibilities to learn in every life-situation, practically without constraints, however, the teachers charisma [7], one of very important motivation factors, becomes lost. Open learning joined with the distance learning mode requires students to become active, almost equal to teachers participants of the education process. It is cause by two factors:

1. In ODL conditions students’ preferences highly influence the market position of a university.
2. Lack of direct contact with the teacher calls for an conscious student, creating his or her cognitive process independently.

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Under the influence of these factors, the education organization management system should consider the new position of the student and reflect it in the frames of a proper motivation model. Source of the research behaviour/attitude:

- Teacher and students should elaborate a new product – the didactic materials repository.
- There is the opportunity to direct collaboration between students and the teacher.
- Student has opportunity to consciously choose a task in accordance with his/her own criteria (e.g. level of task's complexity).

The final result of the student's learning process depends on his/her involvement in the repository development.

The problem of motivation is one of the more important research subjects of psychology and pedagogy. There are many definitions of this concept [8][9], according to which motivation as a phenomenon can be seen as:

a) A system of factors (needs, motives, goals, plans, etc.) determining human actions.
b) A process that supports human activity at a certain level.

When developing a motivation model as a part of an information system aimed at managing an education organization in ODL conditions, one has to define the place of this model in the system, its criteria function and solution method.

In the article, we present a model of a system, in which students and teachers are focus on a new goal - creating the repository with the high quality didactic materials. To achieve this goal, the motivation factors of the learning process participants should be considered, and the analytical mechanism for the assessment of the learning process constrains should be proposed. Our model covers the formalization of the learning process environment based on the motivation and offers a simulation as a mechanism supporting the teacher to influence on his/her and students motivation taking into account the typical learning process constrains (eg., work time).

II. Model of the Didactic Materials Representation

In the conditions of no direct contact between the teacher and students, the scope and way of performing the knowledge-based actions (didactic, research, educational) changes significantly [10]. It occurs due to the various reasons. In the traditional learning, the didactic materials play the complement role to the teacher's charisma and their improvement requires a long time because of the source of knowledge (books, journals, scripts etc.). However, such accumulating and improving of knowledge resources often does not fulfil its purpose due to rapidly changing situation on the technology market. It especially can be seen in a such domains as: computer science (continuously incoming new software frameworks), printing (new pdf-based workflow), banking (new banking products), etc. [24].

Moreover, in traditional learning the motivation occurs through assessing knowledge (tests, exams, etc.). The teacher acts a middle-man between the knowledge source and the student's cognitive process and is responsible for its control [11]. As a management object, the student's cognitive process is characterized by high level of entropy, but through direct contact, through exchanging information, the teacher, on the basis of his/her own competence, continuously lowers the entropy level, meaning that the teacher controls the student's cognitive process in certain boundaries. The effectiveness of this control depends highly on the intensity of interaction and on the interpersonal skills of the teacher.

Kushtina [4] showed that the role of didactic materials in the ODL conditions is greatly increased because of the new expectation - to substitute direct contact and exchange the information between teacher and student. This imposes new requirements to display in the didactic materials not only the information, but also knowledge in the learned subject or topic. Moreover, the role of didactic materials in ODL conditions comes from the assumption that knowledge is a visual and textual information structured according to the goal and level of education.

Processing information received by a human into the form of knowledge takes place with the help of internal cognitive operations like [12]: structuring, coding and clustering as well as creating a kind of internal semantic network, which we can consider subjective ontologies [13].

In order for the didactic material to be in any way capable of playing the role of a broker between the source of information and the cognitive process of a student, it should contain the ontology of the taught subject, developed by the teacher. Currently, the ontology is a widely used method for knowledge representation. There are ontology description languages and programs to operate them. Advantages of using the ontological approach to learning are discussed in [29]. As it was there presented, this method is recognized as a crucial in the development of the student's analytical skills and elaboration the system vision of wide field of knowledge objects and their applications.

A more detailed description of constructing didactic materials on the basis of an ontological model was described by Kushtina et al. [23].

Preparing and making available the ODL didactic material through appropriate computer environment (repository) requires great efforts regarding intelligence and working time of the teacher. The computer aspects of the repository were already discussed by Mayer [14] and the proper repository development involves substantial money capital and consumes a lot of time. Resulting from previous researches shows the need to motivate the teacher to supplement his/her duties with developing and monitoring the state of the repository.

The second difficulty is the necessity to motivate the student to get highly involved in working independently during the education process, what guarantees obtaining a level of competence comparable to traditional education. Assessing knowledge on the basis of traditional tests in the distance learning mode loses its meaning as an instrument of motivation, as it deprived of all the consequences of direct contact with the teacher and other students (cognitive ones, emotional ones, etc.). A substitution way of rising the activity of the person learning something is a “game”, understood as an active cooperation, the result of which will be an object of interest for both the teacher and students (players). In the management sense, it means that the interests of each participant of the cooperation should be described as individual motivation functions that make up one goal function.

The repository is the result of this cooperation, from the didactic point of view it is an open for everyone storage of didactic materials, including ontologies, tasks, example solutions, etc.; from the scientific point of view it is a copyrighted knowledge resource of a university; from the software-technical point of view it is an information system based on an appropriate network platform.

III. Motivation Model Interpretation in the Context of an Education Situation

A motif (the reason of action) is a consciously understood need for a certain object, position, situation, etc., therefore we can state that the motif comes from a requirement, becomes its current state and leads to certain actions [15]. During the realization of the mentioned chain “need – motif – action”, at each step we deal with a decision-situation, meaning: many motifs can lead to a certain action, many needs can make up one motif, many motifs come out of one need. Making a choice is a cognitive process that cannot be observed directly [16]. This means that it is only possible to define the quantitative relationships between the choice parameters through exterior registration of the choice results.

The motivation model can be developed in the form of a certain game scenario, where the activity of a teacher and a student will be supported by their own interests [17]. Developing the motivation model in a specific education situation (subject, goal and education level) is possible with the following assumptions:

- The set of elements of the mentioned chain is defined and contains alternatives.
- The choice is made in a specific education situation.
- The result of a multiple choice made according to the chain is the obtained competence.
- The result can be registered.
- There is a system of assessing the choice results.
- Students and teachers have access to observations and evaluations of the choices, which they made.
- The result of a choice has to be evaluated by the student as a needed and wanted one (usability of the result).
- The student has to be certain that the wanted result can be achieved in a given education situation, with probability higher than zero (subjective probability of achieving the result).

Research’s discussion about motivation model can be addressed to different area of education system. The conducted analysis of information-processing in judgmental tasks allows to prepare cognitive-motivational model of decision's satisfaction [18]. In proposed model, confidence serves a role of a major contributing factor of the learning motivation. However, more details investigation proves that the motivation is a set of several components. The ARCS Motivation Model [19] is based on four-factor theory. The student’s motivation is hooked up with student’s attention, relevance, confidence and satisfaction. The ARCS model also contains strategies that can help an instructor stimulate or maintain each motivational element. Other researchers show that personally valued future goals are core for motivation [20]. Moreover the cultural discontinuities and limited opportunities in students’ learning environment may weak the motivational force in the future [21].

The form and content of motivation model is also strong depended on object to be motivated and environment, where motivational action takes place. On the one hand motivation model can be designed for artificial or human object. DeVoe and Iyengar [22] proposed a motivation model for virtual humans such as non-player characters. The motivation model based on overlapping hierarchical classified systems works to generate the coherent behavioural plans. On the another hand, different environment creates individual needs for motivation model. Such situation is caused mainly by multicultural differences [23].

IV. Stating the Motivation Problem in a Specific ODL Education Situation

In ODL conditions, as a motivation model we consider scenario of a game (interaction, interplay) between the teacher and the students, conducted in a specific education situation and oriented on performing the actions which allow to raise the level of student's involvement in subject-specified task realization and extend the repository with new student's solutions (new tasks).

The education process in every education situation includes the didactic, research and education aspects and takes place at the following levels: cognitive, information and computer-based. At each of these levels the teacher and the students have their own roles and involvement intensity. At the cognitive level assumptions are made and tasks are solved. At the information level the information is exchanged between the participants of the teaching/learning process. The computer-based level is characterized by repository organization and ability to use it. The role of the teacher is to develop an ontological model reflecting the subject of the education situation, showing the source of information, formulating tasks and presenting methods and examples of their solutions. All ontological models are stored in the repository.

In the discussed approach tasks are created on the basis of the ontology and differ in their complexity level [14]. The proposed scenario assumes that the role of the student is to choose a task and solve it. The final grade depends on the correctness of the solution and the complexity level of the task. A task solved by a student and highly graded by the teacher is placed in the repository and will serve as an example solution for other students. All materials stored in the repository are copyrighted. This way the student participates in the didactic activity and we assume that it will raise his/her self-esteem, what has a positive influence on learning, meaning that it will be a part of the *student's motivation function*. At the same time filling the repository with a wide spectrum of high quality solved tasks gives satisfaction to the teacher, for his/her laborious, requiring intelligent efforts of preparing the repository. And this will make up the *teacher's motivation function*.

Teacher's and student's interaction with the repository can have a research character. We assume that thematically the content of the repository is in concordance with the teacher's scientific-research interests, what causes appearance and extension the repository with the tasks differing from the complexity level. For helping to solve tasks stored in the repository, the teacher will pay more attention and spend more time with the students. We can assume that for a certain part of students participation in common research is a challenge and the obtained results are an extra added value.

The educational aspect is reflected in the repository development as a common success of all participants of the education process. Making the material copyrighted shows and visualizes the contribution and involvement of each participant. Feeling the synergy effect motivates to develop cooperation skills and tolerance. Cooperation in distance conditions requires a more logical formulation of questions and answers. All this reflects the interests of both the teacher and the students.

Let us consider the basic components of the motivation model.

Input data

G^D - ontology graph of the domain area *D*,

$G^D = \{W^D, L^D\}$, where

W^D, L^D - set of vertices/arcs of the graph,

$G^C = \{W^C, L^C\}$ - graph of the course *C*, part of the $G^{D,}$ where $W^C \subseteq W^D, L^C \supseteq L^D$,

$R = \{r_i^k\}$ - set of the tasks, where

*i=1,2,..i**- index of task,

*k=1,2,..k**- index of acquired competence,

$S = \{s_j\}$ - set of students/project team, where *j=1,2,...*

*j**- index of student,

$[t_0, T_c\ ]$ - interval /cycle of competence acquiring,

X – repository assigned by the teacher for saving the projects of knowledge,

$G_X(t) = \{W_X(t), L_X(t)\}$ -state of the repository X at the time *t*, where $t \in [t_0, T_c]$.

Decision functions

$y(r_i^k, s_j)$ -student decision's function of the task choice,

$$y(r_i^k, s_j) = \{ \begin{matrix} 1, if\ student\ s_j\ chooses task\ r_i^k \\ 0, otherwise \end{matrix} \tag{1}$$

$\delta^N(p_i^k)$ - teacher decision's function of assignment the task/project to the repository,

$$\delta^N(p_i^k) = \{ \begin{matrix} 1, if\ \ project / task\ p_i^k\ is\ seleceted\ \ for\ repository \\ 0, otherwise \end{matrix} \tag{2}$$

Criterion

$G(p_i^k)$ - ontology graph of the task/project,

$G(p_i^k) = \{W(p_i^k),\ L(p_i^k)\}$, where

$W(p_i^k),\ L(p_i^k)$ - set of the vertices/arcs of the graph

$$W(p_i^k) \subseteq W^c, L(p_i^k) \subseteq L^c \tag{3}$$

$\Delta G_X(p_i^k)$ -knowledge increment caused by the development of the repository *X* by the project p_i^k

$$\Delta G_X(p_i^k) = G_X(t) \bigcap G(p_i^k) = \{W_X(t) \bigcap W(p_i^k), L_X(t) \bigcap L(p_i^k)\} \tag{4}$$

$\left|\Delta G_X(p_i^k)\right|$ -numerical characteristic of knowledge growth in the repository,

$$\left|\Delta G_X(p_i^k)\right| = \delta^N(p_i^k)\left|W^C \cap W(p_i^k)\right|, \text{ where} \tag{5}$$

$\left|W^C \cap W(p_i^k)\right|$- number of common vertices in the ontology graphs G^C i $G(p_i^k)$,

$Z_N(p_i^k)$ - expenditures(expenses) of the teacher's resources: consultation time in task/project p_i^k,

$$Z^N(p_i^k) = \alpha_N \left|G(p_i^k)\right| \text{ , where} \tag{6}$$

α_N - waging coefficient for teacher's expenditures.

Teacher Goal Function

$\Delta G_X^\Sigma(0, T_0)$ - summary increase of the repository *X* in the competence acquiring interval $[t_0, T_c\ ]$,

$$\Delta G_X^\Sigma(0, T_0) = \sum_{i=1}^{i*} \sum_{k=1}^{k*} \sum_{j=1}^{j*} \delta^N(p_i^k)\, y(r_i^k, s_j)\ G_X(t) \bigcap G(p_i^k), \text{where} \tag{7}$$

$\left|\Delta G_X^\Sigma(0, T_0)\right|$ - characteristic of the summary knowledge growth in the repository,

$$\left|\Delta G_X^\Sigma(p_i^k)\right| = \sum_{i=1}^{i*} \sum_{k=1}^{k*} \sum_{j=1}^{j*} \delta^N(p_i^k)\, y(r_i^k, s_j)\ \left|W^C \cap W(p_i^k)\right|, \text{ where} \tag{8}$$

$\left|W^C \cap W(p_i^k)\right|$ - number of common vertices in ontology graphs G^C i $G(p_i^k)$,

Z_N^{Σ} - summary expenses/expenditures of the teacher's resources: consultation time, etc., in the competence acquiring interval $[t_0, T_c\ ]$.

$$Z_N^{\Sigma} = \sum_{i=1}^{i*} \sum_{k=1}^{k*} \sum_{j=1}^{j*} \alpha_N \, y(r_i^k, s_j) \left|W(p_i^k)\right|, \text{ where} \qquad (9)$$

α_N - waged coefficient of the teacher's expenses/ expenditures,

$\left|W(p_i^k)\right|$ - number of vertices in the task/project

$G(p_i^k)$ - ontology graph,

Φ^N - teacher's goal function: summary increase of the repository X in the competence acquiring interval $[t_0, T_c\ ]$ accounting teacher's expenses

$$\Phi^N = \left|\Delta G_X^{\Sigma}(0, T_0)\right| - Z_N^{\Sigma} =$$

$$\sum_{i=1}^{i*} \sum_{k=1}^{k*} \sum_{j=1}^{j*} y(r_i^k, s_j)\{\delta^N(p_i^k) \left|W^C \cap W(p_i^k)\right| - \alpha_N \left|W(p_i^k)\right|\} \quad (10)$$

Student's goal function

$\Phi(s_j)$ - goal function of student s_j : number of ECTS (European Credit Transfer System) points accounting student's expenses for execution the task/project p_i^k

$$\Phi(s_j) = \sum_{i=1}^{i*} \sum_{k=1}^{k*} y(r_i^k, s_j) \gamma^N(p_i^k) \left|W^C \cap W(p_i^k)\right| - \beta^S \left|W(p_i^k)\right|, \text{ where } (11)$$

$\gamma^N(p_i^k)$ - number of ECTS points assigned by the teacher for execution the task/ project p_i^k,

$\left|W^C \cap W(p_i^k)\right|$ - numerical characteristic of growth of the repository as result of task/project p_i^k execution,

$\left|W(p_i^k)\right|$ - numerical characteristic the time-consuming of the task/project p_i^k

β^S - weight coefficient of student's expenses for execution the task/project.

V. Motivation Model Identification in the Games Theory Terminology

Interpretation and solution of the developed model can be conducted on the basis of the games theory, which allows to study the activity of a system depending on the players' behaviour.

The way to involve students in active learning is to create a game situation, which is as follows. A distinctive feature of the ontology developed for educational purposes is that the ontology graph contains different types of subject knowledge: theoretical (what's this?) and the procedural (how to do this?). Theoretical vertices describe the semantics of the concepts and their relationships, and procedural ones - test tasks associated with the corresponding path in the graph. The project task to develop the domain ontology with both types of vertices can be represented as a game with total win and distribution points depending on the student's participation.

Overall gain is considered as the number of both types vertices, added to the domain ontology graph, stored in the repository as a new didactic material. Teacher plays the role of the head of the game, students are combined into sub-groups or can play individually. Motive of the teacher is to extend and update the repository by the independent work of students. Motive of the student is to study the subject under teacher's supervision using live chat, competition recognition, stress reduction compared to traditional testing, increase the choice possibility, etc. The game can be carried out remotely [24]. Some students may choose the simplest tasks and the traditional way of its solution. Final assessment depends on the task complexity, participation in the project, the number of ECTS points.

The proposed model refers to the class of non-cooperative games with a defined number of steps and full information about participants activities in real-time. The game has an arbitrary sum of participants' *wins*: the *win* of the teacher is accrual of knowledge in the repository, the *win* of the student depends on his/her strategy: maximal number of points for a task solved or minimal time loss. The equilibrium is obtained as a result of a dominant strategy, what compared to other strategies gives the game participants the possibility to obtain their maximal *win* regardless of actions of the other participants.

Using game theory terminology the motivation model can be seen as a stimulation task, where motivation management signifies direct rewarding an agent (student) for his actions. The formulated model is consistent to a multi-agent two-layer stimulation system which consists of one centre (teacher) and *n* agents (students). The strategy of each agent is to choose an activity, the centre's strategy – to choose a stimulation function, i.e., relationship between the win of each agent and his actions.

Participants' preferences are reflected by goal functions. The centre's (teacher's) goal function is the difference between his/her reward (ΔW) and the summary reward paid to the agents (sharing one's own resources ($\bar{X}$)). By goal function of each agent, we understand the difference between the reward obtained from the centre and the losses connected to solving the task. At the moment of making the decision (stimulation function for the centre and choice function for the agent) the goal functions and acceptable actions of all participants are known. The centre has the right of the first move, when it chooses a stimulation function, before the agents, with known stimulation functions, choose activities that optimize their goal functions. The centre's choice of a stimulation function takes place on the basis of a simulation meant to serve in foreseeing random characteristics of the basic students knowledge and parameters of the process of their arrival Agents choose their strategies independently and do not exchange information or wins, this signifies that we are dealing with a relational dominant strategy.

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Let us denote: M - a set of acceptable stimulation methods, $Y(\sigma)$ - a set of game solutions (strategy of agents having balance in their stimulation method σ). Management (stimulation) effectiveness means obtaining maximum value of the goal function $U(\sigma)$ on an appropriate set of game solutions.

$$U(\sigma) = \max_{y \in Y(\sigma)} f(\sigma, y), \qquad (12)$$

where σ is a simulation function of the centre, y is a binary argument of agent's choice. The task of optimization stimulation function synthesis is about searching for an acceptable stimulation function with maximum effectiveness:

$$\sigma^* \in Arg \max_{\sigma \in M} U(\sigma). \qquad (13)$$

When solving the model, algorithms proposed by Shubik [24] and Gubko and Novikov [25] can be used.

VI. SIMULATION MODEL OF THE TEACHER AND THE STUDENT CO-OPERATION IN THE COMPETENCE ACQUIRING PROCESS

Transferring of represented ontological/mathematical model to a simulation platform requires a set of actions. Key factor is defined as an elementary event at the input of the system. Moreover it's necessary to define a kind of arrival pattern: deterministic or stochastic one and the rate of arrival.

The goal of the simulation model and experiment is realization and analysis the didactical process oriented on acquiring competence. Simulation experiment deals with virtual reality and transforms the real learning/teaching process. Using the charge of the resources and other output parameters it is possible to change model of co-operation between teacher and student and plan the competence development. General scheme of simulation model is shown on figure 1. Elements (events) of simulated process are incoming students' tasks and time of teacher's consultation. Students arrive independently, sequentially and each event has to be served.

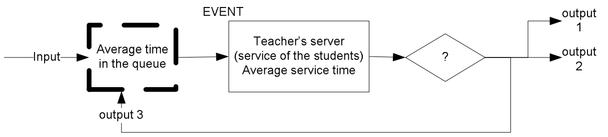


Figure 1. General scheme of simulation model.

On the base of outcome data teacher can change strategy of work with the students and modify motivation function, what means changing the complexity of the tasks setting up background of competence, e.g., to give more simple tasks, that in turn reduces the charge of the teacher and level of acquired competence. Simulation model provides also the estimation of various variants of teacher's work in different constraints of the education situation (time, kind of students group, etc.).

In conditions of the simulation experiment, the process of teacher and student co-operation can be interpreted as a queuing system with the following characteristics:

- Teacher's work relies on examination the students' task while the content and learning objects are known.
- For a given course and a group of students teacher's workplace can be defined as a server with known input, output and average time of service.
- Average time of service depends on the teacher's experience (specific character of course, task complexity, kind of student group, time of studies, etc.) and the results received from the linguistic database; its value is used in the motivation mechanism.
- Workflow of students arrival is stochastic: it's unknown number of arriving students, time of task evaluation, etc..
- Incoming tasks are served with 1 server, characterized by time and discipline of servicing.

Interpreting the given problem in terms of queuing system provides possibility to use well known analytical result for certain class of QS (Queuing Systems) (e.g., M/M/1 for Kendall notation) [30].

Implementation the simulation approach can be realized in the Arena software, which in flexible way gives possibility to research parameters of the education situation: waiting queue, predictable time of servicing of all students, charge of the teacher in specified distribution law of the students' arrival, etc.

Interpretation of the teaching/learning process oriented on acquiring competence in the terms of simulation modelling requires to define the components of this process, which impact its run (Figure 2). These components permit to consider the teaching/learning process as a production one. It results in growth of competence represented by the new repository resources.

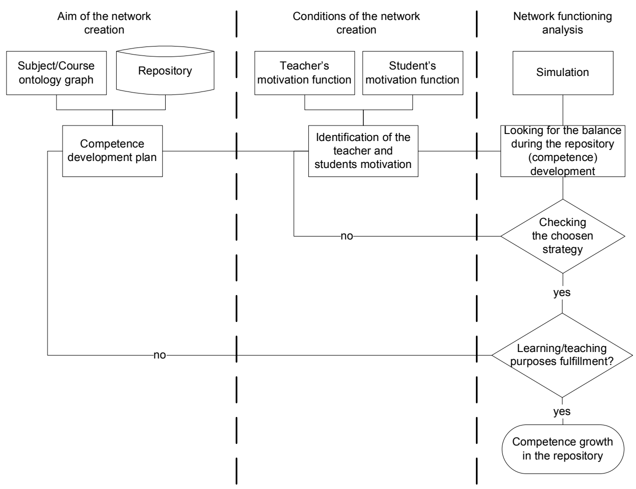


Figure 2. The components of the learning process oriented on acquiring competence [27].

First component of the teaching/learning process is competence development plan directly involved with the repository's ontology and the gathered resources. It permits to specify the tasks assigned for the repository - number of these tasks and theirs complexity level. The determining of the motivation function follows the setting of numerical parameters value. Teacher’s motivation function depends on time of tasks control, number of task assigned for the repository and discipline of students' servicing. Meantime, determining the student’s motivation function which essentially impacts on the competence development plan is difficult problem. To solve this problem some probabilistic approach based on linguistic database can be proposed. It allows to define the cognitive potential of the group of student. Such database requires to specify and aggregate the features defining the student's motivation function.

A set of features that allow for identification the student's motivation function is the following:

1. Self-estimating (self-assessment) of knowledge perception capability.
2. Estimating (assessment) of the teacher's requirements.
3. Quality of delivered didactic materials.
4. Interest of the subject content.
5. Didactic material capacity and its curriculum.

According to Goodhew [11], every feature sets numerical scale for linguistic quantifier. Distribution law of the linguistic quantifier for the feature ‘Quality of the didactic materials’ is represented in Figure 3.

Realising at the next steps, partial aggregation of the features in accordance with the linguistic database model enables to define expected level of student motivation in the teaching/learning process (Figure 4).

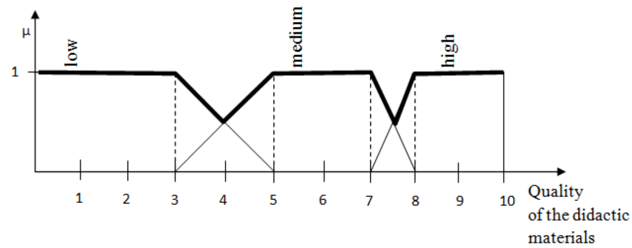


Figure 3. Distribution of the linguistic quantifier for the feature 'Quality of the didactic materials'.

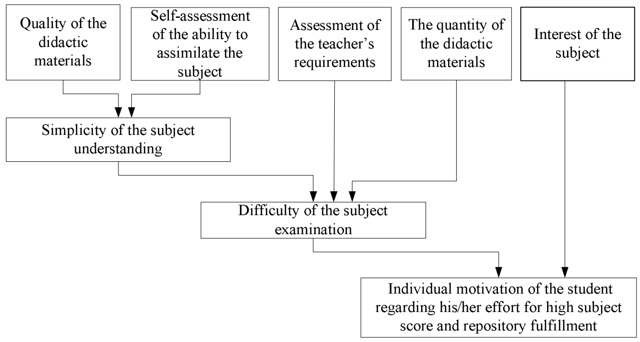


Figure 4. Model of linguistic database for student's motivation estimation [27].

Analysis of student's motivation on the base of the linguistic data/knowledge base defines cognitive potential of the students’ group and their interest in the repository development. The results of analysis can be used for evaluation the simulation model parameters: number of students with high, middle and low motivation, interests in the repository development, number of tasks for correction .

The simulation model, represented in Figure 5, allows to verify parameters of the teaching/learning process and to make some changes in teacher’s strategy with the group of students. It is based on assumption that "arriving" students must be served by the teacher. The result of this service is a new competence (with or without new resources in the repository) or (in otherwise) student must be declined for correction [12]. This approach allows to interpret the teacher’s work with students as queuing system, where:

- For a given content of the didactic materials teacher’s work refers to checking the executed students’ tasks.
- For a given subject and students' group teacher's workplace can be examined as a server with a given input, output and average service time.
- Students arrival in the queuing system with the known parameters of stochastic workflow.
- Average service time depends on teacher’s experience and results from the linguistic knowledge base analysis.

Simulation experiment was realised in Arena software. Co-operation between the teacher and the students was analyzed taking into account the time the teacher has spent with the students in the certain level of the repository development.

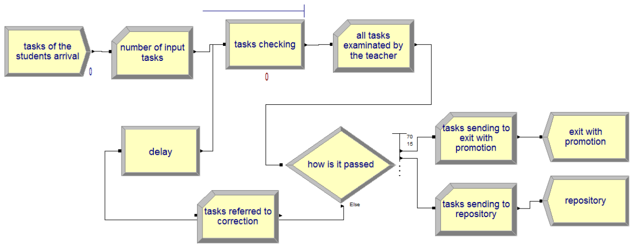
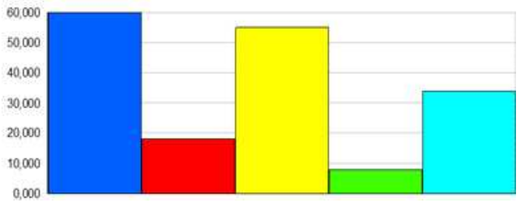


Figure 5. Scheme of the simulation model of the teacher's work with the students' tasks in Arena software [26].

Some parameters which can be analysed on the base of the simulation model are the following:

- Waiting queue on the teacher's workplace.
- Average waiting time of a student.
- Number of tasks completing the teaching/learning cycle with the repository development.
- Number of tasks allowing to pass the subject without fulfilment the repository.
- Number of tasks referred to correction.
- Total time required for the teaching/learning process realisation.



COLOUR	CRITERION	ACHIEVED VALUE
	number of input tasks	55
	tasks sent to exit with promotion	34
	tasks sent to repository	8
	tasks referred for correction	18
	all tasks examined by the teacher	60

Figure 6. Results of the simulation experiment used for estimation the teacher's strategy in collaboration with the group of students [27].

The results of simulation modelling represented in the Figure 6 can be used for analysis the behaviour or strategy of the teacher. The simulation model can be multiply modified and used for balancing the parameters of service the group of students.

VII. CONCLUDING REMARKS

The motivation model has to be an obligatory element of an open and distance learning system. The proposed model constitutes the theoretical formalization of the new situation, when a teacher and the students are obligated to elaborate a didactic materials repository in accordance with the competence requirements. It covers two motivation functions: teacher's and student's, which describe their interests in the knowledge repository development. The proposed approach to the motivation provides not only the efficiency of teacher's work in ODL condition, but also the high quality didactic materials oriented on competence achievement. The measure of success in cooperation between the teacher and the students, according to the presented scenario, is the level of the repository content development in a given time.

To analyze the constrains of this cooperation, it is proposed the simulation approach. The possibility of assessing the various variants of teacher's work in different education situation by using the simulation models and simulation software lets to change this cooperation on the basis of empirical results.

The interpretation the cooperation between the teacher and the students in a game theory causes, that the proposed motivation model can be solved on the basis of one of the known algorithms realizing a non-cooperative game with dominant strategy (RDS) [30].

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