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Applying systems methodology of dynamic modeling to monitoring of students' effective communication skills

In recent decades monitoring of complex processes developing in time has been used extensively in research related to the study of natural processes. However, the monitoring of social, psychological, linguistic, and other non-visual processes, such as human communication, remains a new, insufficiently explored, albeit very promising area of research. Monitoring, i.e. continuous observation of processes with the idea of evaluating their states and building prognostic scenarios of their development is applied in cases when researchers need to simultaneously explore a system of multiple interrelated components, which are affected by continuous external influences. Human communication represents exactly this type of a complex, multi-component dynamic system. It combines a variety of linguistic and extra-linguistic elements [2] and appears as a repeated sequence of actions [1], which should be studied in

the development and in the full variety of internal and external influences on its multiple components. Monitoring of such complex processes has become possible in recent decades due to the rapid development of a new scientific methodology of dynamic systems modeling, which suggests a way build detailed models of communication processes, from prognostic scenarios of their development, and study reactions of the models to any external and internal influences. The combined expertise of psychologists, educators, and linguists about the structure and sequence of communication process provides information sufficient for representing the process as a dynamic system; by applying informational technologies of dynamic modeling, continuous monitoring of the system becomes possible. The results of such monitoring can be used for development of new programs as study oriented at students' communication skills development in the course of their university study.

The research carried out by the faculty of the Department of Foreign Languages and Translation/Interpreting at the National Technical University "Kharkiv Polytechnic Institute" was aimed at applying dynamics modeling methodology to the study of the students' communication skills development process. It included several steps:

1. Putting together and processing expert information about the process into a research database in accordance with scientific principles and concepts of sustainable development [3]. At this step, goals of communication skills development process were set, a draft verbal model was developed to unite all components of the communication process into a system of interrelated elements. A revised program of study was suggested to the students participating in the experiment; a general diagram of communication skills monitoring was drafted, and initial evaluation of the participants' communication ability carried out [1].

2. Building informational technology of the research. At this step, the process of communication was regarded as a system, containing multiple linguistic and extralinguistic components. Anticipated connections and mutual influences between these components were identified by experts; all information was entered into a diagram [3, 4].

3. Creating models for simulation of communication skills development processes. Multiple simulation experiments were conducted, the results of simulation experiments were compared to the outcome of classroom observations.

4. Adaptation of the models: grounding on results of observations, data assimilation operations were implemented and new prognostic

scenarios of communication skills development were obtained. Repeated simulation experiments were followed by model adaptation operations and resulted in new development scenarios.

5. Summing up the results of the research and building conclusions regarding application of the scientific methodology of dynamic modeling to monitoring of students' communication skills development process.

An exceptional role in the research was given to the task of describing the process of communication and creating a database of expert knowledge about it. Lists of parameters, characterizing communication process were put together based on the most recent expert knowledge about the phenomenon; all parameters were then united into a verbal, and later into a conceptual (graphical) model of the communication process. During this stage of research, descriptions of all known linguistic and extralinguistic parameters influencing the process of communication were performed; probable factors of influence between the parameters were identified, and their possible impact on communication skills development processes were studied. Special attention was given to the problem of description of pragmalinguistic parameters, such as locutionary, illocutionary and perlocutionary acts of communication process [1], as well as to the typology of illocutionary acts and introducing all kinds of speech acts into the experimental model as the communication process parameters. In the course of the experiment, conclusions were made regarding entering a maximum number of factors characterizing the process of communication itself, as well as about entering a number of factors, potentially capable of influencing the efficiency of the skills development process. Thus, the expert knowledge about the process of communication itself was enriched and upgraded by a deeper understanding of the specifics of the communication skills development process.

Having obtained the most accurate information about the process of communication, the authors regarded it as a system of interrelated components and determined the most probable factors of negative and positive influences between all components of the system. For example, such extralinguistic factor as emotional tension at the time of communication has an obvious adverse effect on the ability to speak logically and conclusively, while in cases of communication in foreign languages, it can also affect purely linguistic factors, such as the ability to use correct grammar structures and make the right choices of words. Further on, in accordance with the general scientific conception of systems sustainable development, all components of the communication

process and information about their mutual influences were formalized (presented in the mathematical form) in a computer-based model, which produced prognostic development scenarios of the dynamic system of communication.

Let us note that, for the sake of brevity, we will further use the term "dynamic system" to identify the development processes within the studied system. According to the requirements of the system conception of sustainable development, in the schematic representation, the monitored dynamic system must be located between the blocks of "development goals" and "possible scenarios", as shown in Fig. 1.

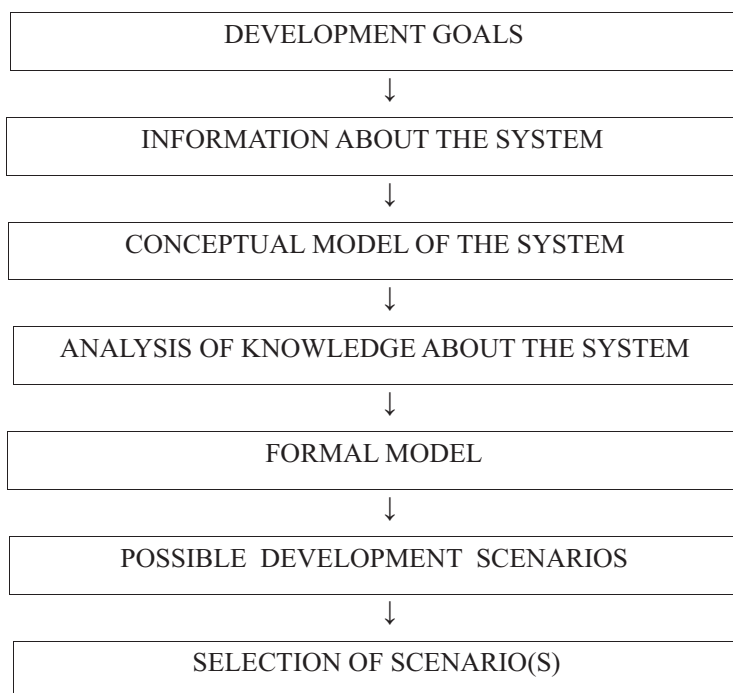
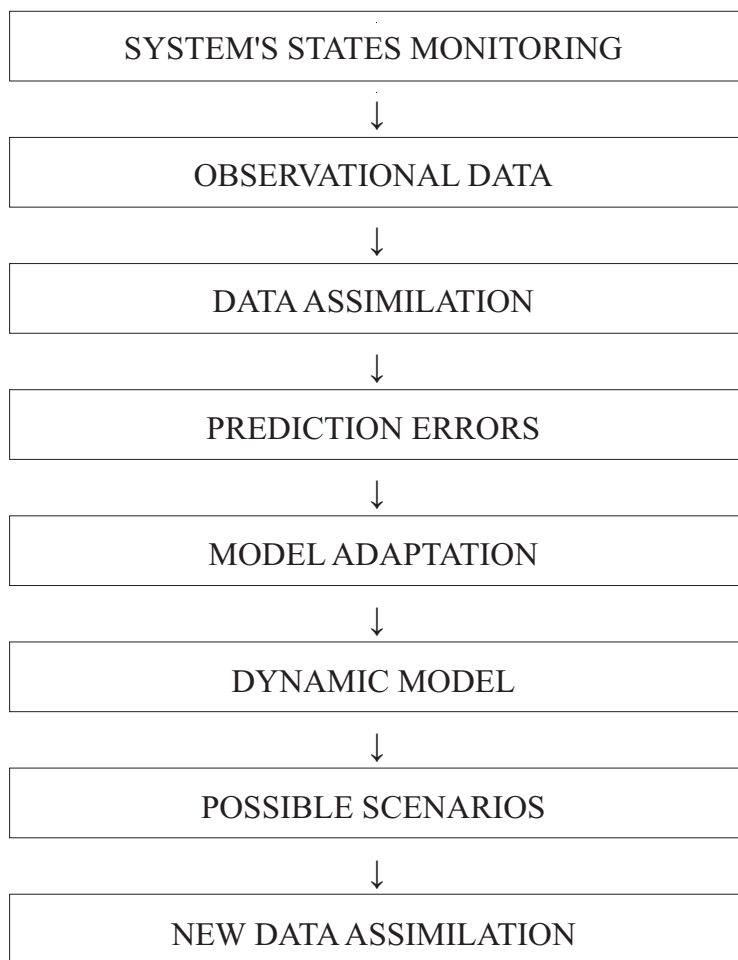


Fig. 1. A dynamic model of the system

It is necessary to say a few words about describing the system of communication skills development and about further transformation of this information into a model. There are three most widely used ways of describing systems: a verbal method (verbal description), a conceptual

method (a graphic image, a diagram), and a formal method (by presenting information as a system of mathematical equations) [3, 4, 5]. Each of these descriptions provides a corresponding model of a system. The conceptual model of the system of communication skills development was built on the basis of the verbal description of components and steps of the communication process, and the research goals which were set at a certain point in the process. Therefore, the process of obtaining possible scenarios of communication skills development included consistent use of all three description methods in the monitored system. This is shown in picture 1, where the block «Information about the system» implies its verbal description. Let us also stress the importance of the dynamic model for monitoring of communication skills development. It allowed the authors to simulate various scenarios of the process, which provided opportunities for choosing one of possible development scenarios and made further monitoring of the system's states possible. This is why special attention was paid to making certain that the dynamic model was adequate to the real processes taking place in the communication process. To test the adequacy of the model, regular experiments were conducted to compare the model scenarios derived from observational data with actual classroom communication scenarios. In addition to this, the data obtained during classroom observations were entered into the model on the regular basis and used as initial conditions for the further projections.

The process of the students' communication skills development took place under the constant expert supervision and was accompanied by obtaining of data during classroom communication and their submission into the computer-based dynamic model (the so-called model adaptation operations), which allowed the authors to come up with new prognostic scenarios of the communication skills development process. This part of the research took place in the block «Systems states monitoring», as shown in picture 2. The data resulting from observations of the students' communicative activity were received in the block "Data assimilation". The assimilation of observational data opened a way to use the methodology of dynamic modeling for providing the most realistic diagnosis of the states of the system. The accuracy evaluation of the model scenarios, developed from observational data, made it possible to vary the coefficients of the dynamic model so that the forecast errors were minimized. The adaptation of the prognostic scenarios to the actual processes of communication skills development was carried out simultaneously with the changes in the actual structure of the dynamic system.



Pic. 2. Dynamic model adaptation

The skillful participants of an effective communication process are supposed to use all available linguistic and extra-linguistic means to achieve the anticipated goals of communication [3]. At the same time, the communication process will only be regarded effective when both sides of the dialogue decode the meanings of what has been said correctly and distortion of the meaning remains minimal [1]. To carry out such communication, interaction dynamics of numerous non-visual factors must be taken into account. Factors like individual characteristics of the participants (their age, social status, sex, occupation, interests, etc.),

the spatiotemporal characteristics of the communication process, as well as the cultural aspect, the ability to listen and to hear each other, a set of communication strategies, compliance with general ethics of communication, and a variety of other influential factors [1] were identified, analysed, and entered into the dynamic model of the system. To set up the work of the formalized model, each component of the system was assigned a numerical coefficient corresponding to the degree of its anticipated influence on other components of the system; depending on the character of the anticipated (positive or negative) impact, every parameter acquired a mathematical sign (positive or negative) in the formal model. Thus, the conceptual model, and later the formal model, united all possible internal influence factors, describing the positive and negative impact of various system's components on each other. The application of a systems dynamics method of the adaptive balance of clauses (ABC-method) [4] allows taking into account external influences on the states of the model. The factors of external influence which impact the process of communication skills development was also identified and studied within the dynamic system.

Monitoring of communication skills development system allowed the authors to collect very valuable information, which will become the subject of scientific discussion in our further publications. In general, it should be noted that monitoring of complex dynamic systems, such as the system of communication skills development, requires combined expertise of several fields of science and includes three main tasks:

1. Building conceptual (graphical) models of the system on the grounds of dynamic systems modeling methodology [5].

2. Formalization of conceptual models, i.e. submission of necessary data into a computer program which is capable of processing large amounts of information and building dynamic scenarios of the system's behavior [4].

3. Creating an informational technology as the methodological background of the system's monitoring process. The methodology used for building conceptual models is based on the principles of systems analysis [5]. The stage of conceptual modeling involves a thorough analysis of cause-effect relations between components of the system, which is followed by formalizing of the model by a relatively simple mathematical method of the adaptive balance of clauses (ABC-method) [3]. This step was performed within a computer program.

The development of informational technology required repetitive use of dynamic modeling methodology, as it involved the repeated

adaptation of prognostic models to the results of real-time observations [3]. These operations were applied for the first time to the research of such a complex, non-visual process as human communication.

In conclusion, it should be noted that this publication is only a brief example of applying dynamic modeling to the study of complex intellectual, psychological, educational and linguistic processes. Currently, the authors are preparing the database for the building of conceptual models to study intonation flow and perform sentiment analysis of texts; another perspective area of research is monitoring of speech patterns and clichés, used by the students during communication in foreign languages. In further research, the methodological framework of the research will also be expanded.

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Abstracts

АНТОНІНА БАДАН, ІРИНА ТИМЧЕНКО. Моніторинг процесу формування навичок ефективної комунікації у студентів із застосуванням методології моделювання динамічних систем. Моніторинг процесу формування навичок ефективної комунікації вперше проведений із застосуванням загальнонаукової методології динамічного моделювання систем. Лінгвістичні та екстралінгвістичні характеристики процесу формування навичок ефективної комунікації розглянуті як динамічна система, що об'єднує безліч взаємопов'язаних компонентів. Описано етапи дослідження, запропоновано інформаційну технологію моделювання, проведено численні експерименти серед студентів в.н.з., підтверджено ефективність моніторингу навичок комунікації із застосуванням загальнонаукової методології моделювання динамічних систем.

Ключові слова: навички ефективної комунікації; моделювання процесу комунікації; інформаційна технологія, динамічне моделювання, моніторинг процесу комунікації.

АНТОНИНА БАДАН, ИРИНА ТИМЧЕНКО. **Мониторинг процесса формирования навыков эффективной коммуникации у студентов с применением методологии моделирования динамических систем.** Мониторинг процесса формирования навыков эффективной коммуникации впервые осуществлён с применением общенаучной методологии моделирования динамических систем. Лингвистические и экстралингвистические характеристики процесса формирования навыков эффективной коммуникации рассмотрены как сложная динамическая система, объединяющая множество взаимосвязанных компонентов. Описаны этапы исследования, предложена информационная технология моделирования, проведены многочисленные эксперименты в среде студентов вуза, подтверждена эффективность мониторинга навыков коммуникации с помощью общенаучной методологии моделирования динамических систем.

Ключевые слова: навыки эффективной коммуникации; моделирование процесса коммуникации; информационная технология, динамическое моделирование, мониторинг процесса коммуникации.

ANTONINA BADAN, IRYNA TYMCHENKO. **Applying systems methodology of dynamic modeling to monitoring of students' effective communication skills.** Monitoring of effective communication skills is performed for the first time with the use of systems dynamics methodology of modeling. Linguistics and extralinguistic characteristics of the communication skills development process are considered as a complex dynamic system that combines multiple interrelated components. The informational technology of modeling is suggested, stages of research identified, simulation experiments performed among university students, the effectiveness of applying the methodology to effective communication skills monitoring are confirmed.

Key words: effective communication skills, communication process simulation, informational technology, dynamic modeling, communication skills monitoring.