

PERSPECTIVE OF GAME THEORY IN EDUCATION FOR SUSTAINABLE DEVELOPMENT

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Abstract

The sustainable development of society has attracted a lot of research efforts. A strategic aspect to the society's evolution is introduced by the game theory (Fernandez, 2011, p. 1). The research question is as follows: how to organize the process of teaching and learning in education for sustainable development? The aim of the research is to model the process of teaching and learning in education for sustainable development. The present research involves a process of analyzing the meaning of the key concepts "education for sustainable development", "game theory", "social situation". Moreover, the study demonstrates how the key concepts are related to the idea of "the process of teaching and learning". The empirical research was carried out in the *English for Academic Purposes* course of Riga Teacher Training and Educational Management Academy in 2008-2009. The sample included 10 students. The findings of the research allow modelling the process of teaching and learning in education for sustainable development. Directions of further research are proposed.

KEY WORDS: Education for Sustainable Development, Game Theory, Social Situation, the Process of Teaching and Learning

1. Introduction

The sustainable development of society has attracted a lot of research efforts. The results of research activities demonstrate diversity in terms of scientific and theoretical fundamentals as well as complexity of prevailing concepts and current practical applications. However, many researchers agree that education is the key area that puts economy, environment and society as depicted in Figure 1 into mutual interaction, contributing to the sustainable development of society (Lifelong Learning for Creativity and Innovation, 2008, p. 3).



Figure 1: Dimensions of sustainable development

Therein, education is centred on the process of teaching and learning. Consequently, education for sustainable development means the process of teaching and learning for sustainable development, too. It should be mentioned that sustainable development in the present contribution is interpreted as long-term development of "relationships and inter-relationships between nature, society and the economy" (Kaivola, Rohweder, 2007, p. 24). In other words, sustainable personality is a person who is able to develop the system of external and internal perspectives as demonstrated in Figure 2, and in turn the system of external and internal perspectives becomes a main condition for the sustainable personality to develop (Ahrens, Zaščerinska, 2010, p. 180).

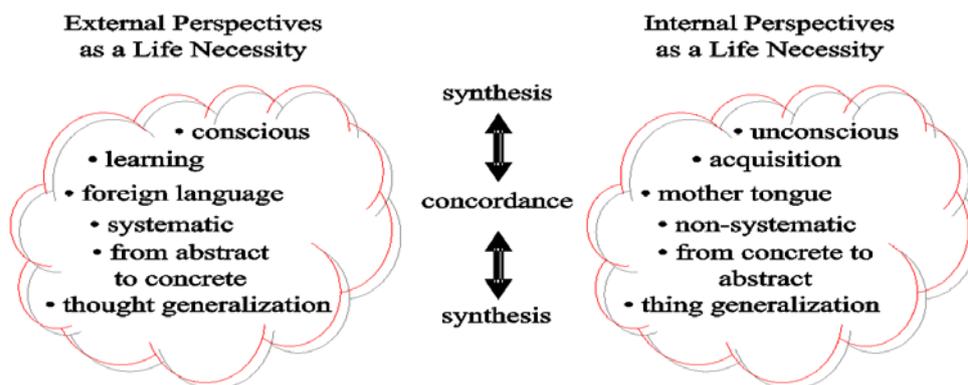


Figure 2: Development of the system of external and internal perspectives as a life necessity

Modelling of the change of the society and within the society and, consequently, the process of teaching and learning in education for sustainable development has become of increased interest to many researchers. Moreover, social nature of change and development has been demonstrated (Leont'ev, 1978). The search for a strategic aspect to the society's evolution leads to the game theory (Fernandez, 2011, p. 1): "The subsequent development of evolutionary game theory has produced a theory which holds great promise for social scientists" (Fernandez, 2011, p. 1). It should be mentioned that the terms "strategy", "approach" and "methodology" are used synonymously. Hence, the research question is as follows: how to organize the process of teaching and learning in education for sustainable development?

The remaining part of this paper is structured as follows: The aim of the present contribution is determined in Section 2. Section 3 demonstrates the object of the present research. Methods and methodologies of the present research are shown in Section 4. Section 5 presents theoretical framework of game theory for modelling the process of teaching and learning in education for sustainable development, whereas in Section 6 some empirical results are evaluated. Afterwards, conclusions on influence of the process of teaching and learning on students' learning outcomes and perspectives of game theory in education of sustainable development are given in Section 7. Finally, some concluding remarks and a short outlook on interesting topics for further work are elaborated.

2. Aim of the research

The aim of the research is to model the process of teaching and learning in education for sustainable development.

3. Object of the research

The object of the research is development of students' learning outcomes in the process of teaching and learning in education for sustainable development.

4. Methods and Methodologies

The present research involves a process of analyzing the meaning of the key concepts "education for sustainable development", "game theory", "social situation". Moreover, the study demonstrates how the key concepts are related to the idea of "the process of teaching and learning". Methodological background of the present research is based on System-Constructivist Theory introduced as New or Social Constructivism Pedagogical Theory. System-Constructivist Theory and, consequently, System-Constructivist Approach to learning introduced by Reich (Reich, 2005) emphasize that human being's point of view depends on the subjective aspect: everyone has his/her own system of external and internal perspectives that is a complex open system (Ahrens, Zaščerinska, 2010, p. 182) and experience plays the central role in the knowledge construction process (Maslo, 2007, p. 39).

The research methodology based on the methodological background of the present research is identified as development of the system of external and internal perspectives as shown in Figure 2. The methodology of development of the system of external and internal perspectives proceeds from the external perspective to the internal perspective through the phase of unity of external and internal perspectives (the system of interacting phenomena) as demonstrated in Figure 3. Moreover, the authors' position on the present research based on the methodology of development of the system of external and internal perspectives is reflected in principles of mutual sustainability and mutual complementarity. The principle of mutual sustainability means to provide a complex of possibilities to learn for everyone (both student and educator in the present research), and reflected principle of complementarity reveals that the opposite things (principles in the present research) supplement each other for finding the truth.

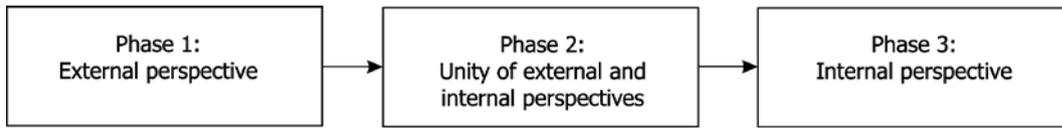


Figure 3: Phases of development of the system of external and internal perspectives

5. Theoretical Framework of Game Theory for Modelling the Process of Teaching and Learning in Education for Sustainable Development

A game is defined as a formal description of a strategic situation (Turocy, Stengel, 2001, p. 2). In its turn, game theory is determined as the formal study of decision-making where several players must make choices that potentially affect the interests of the other players (Turocy, Stengel, 2001, p. 2). Moreover, what economists call game theory psychologists call the theory of social situations, which is an accurate description of what game theory is about (Levine, 2011, p. 1).

Social situation is defined as the source of psychological development. The present research is based on the definition of social situation of development as the unity of outside developmental circumstances and individual's psychological characteristics in his/her experience (Surikova, 2007, p. 254). Social situation is also defined as situation of interaction, social interaction or social-cultural environment (Surikova, 2007, p. 254). Therein, the terms "social situation", "situation of interaction", "social interaction" and "social-cultural environment" should be used synonymously.

Social situation is centred on the social *activity*. It should be noted that the *activity* concept originated with Vygotsky (Blunden, 2009, p. 10), although Activity Theory is associated with the name of Leontyev (Leont'ev, 1978, p. 7) rather than Vygostky (Vygotsky 1934/1962). In order to determine a mechanism of the development of social situation for modelling the change of the society and within the society, Vygotsky's Law of Development or interiorization (Vygotsky, 1934/1962, p. 89) is analyzed. Law of Development is defined by Vygotsky as transformation of the external culture into the individual internal (Wells, 1994, p. 3) that means that any function in the individual cultural development appears twice or on two planes (Wells, 1994, p. 3): *first, on the social level and later, on the individual level*. The social level (the external perspective) accentuates social interaction of development (Surikova 2007, p. 253). Therein, social interaction is determined as the unity of outside developmental circumstances and individual psychological characteristics in his/her experience (Surikova, 2007, p. 253). The individual level (the internal perspective) focuses on cognitive activity (Surikova 2007, p. 253). Cognitive activity refers to the unity of processes of sense, perception, attention, memory, thinking, speech and imagination, by which people perceive, remember, think, speak, and solve problems. In other words, any function in the individual cultural development appears at the beginning between people (as interpsychical or intermental category), and then – on the intrinsic level (as intrapsychical or intramental category) (Wells, 1994, p. 3). As the process, the development of social situation has its cyclic nature. Hence, the development of social situation proceeds from individuals' social interaction to his/her cognitive activity as depicted in Figure 4.

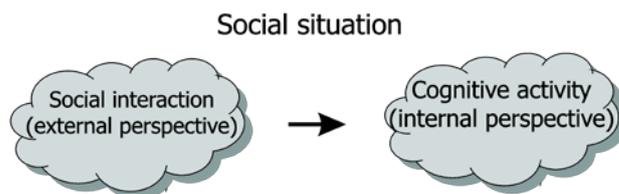


Figure 4: Development of social situation in psychology

Moreover, the sub-phase between the social level (the external perspective) and the individual level (the internal perspective) is determined as the phase of unity of external and internal perspectives (the system of interacting phenomena) as shown in Figure 5.

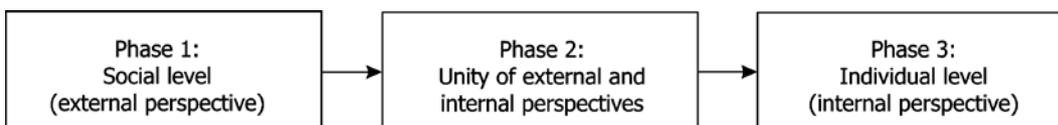


Figure 5: Phases of development of social situation

Thus, the development of social situation proceeds from the external perspective through the phase of unity of external and internal perspectives (the system of interacting phenomena) to the internal perspective as demonstrated

in Figure 5. Moreover, psychological processes are the basis for development from the perspective of pedagogy and, consequently, education.

In pedagogy and, consequently, in education for sustainable development social situation is defined as social-cultural environment (Surikova, 2007, p. 254). Social-cultural environment is centred on the teaching and learning process (Graves, 2008, p. 152). Therein, the term *the teaching and learning process* based on Activity Theory by Leontyev (Leont'ev, 1978, p. 7) comprises use of terms such as *activity* and *studies*. The terms “activity”, “studies” and “process” should be used synonymously. The teaching and learning process in education for sustainable development is considered within the frame of the methodological approach of development of the system of external and internal perspectives. Figure 6 demonstrates the inter-relationship between the teaching and learning process and the methodological approach of the development of the system of external and internal perspectives: the external perspective includes teaching, the phase of the unity of external and internal perspectives and/or the system of interacting phenomena comprises peer-learning, and the internal perspective involves learning.

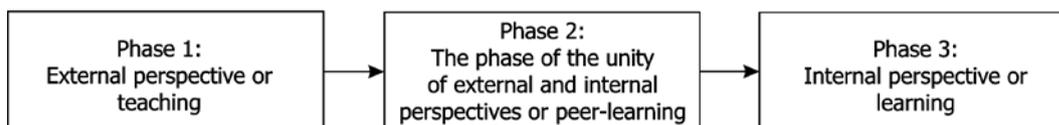


Figure 6: Inter-connections between the teaching and learning process and the methodology of development of the system of external and internal perspectives

Thus, the teaching and learning process in education for sustainable development proceeds from teaching in Phase 1 through peer-learning in Phase 2 to learning in Phase 3 as shown in Figure 7.

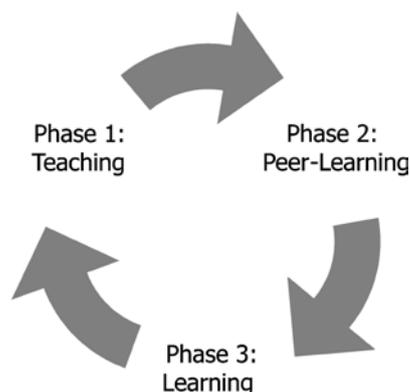


Figure 7: Phases of the teaching and learning process

Each phase of the process of teaching and learning is separated from the previous one, and the following phase is based on the previous one. Phase 1 *Teaching* starts with preparing the students for the process of teaching and learning, planning the procedure of the process of teaching and learning, equipping teaching/learning class, determining the purpose, etc. Then, Phase 2 *Peer-learning* is aimed at doing an exercise and making a decision. Finally, Phase 3 *Learning* focuses on the evaluation of both individual achievements and results. Students gradually proceed from the external regulation and evaluation in Phase 1 to the self-regulation, mutual evaluation and self-evaluation in Phase 3. Moreover, the paradigm shift from an input based teaching/learning process to an outcome based process (Bluma, 2008, p. 673) determines that learning outcomes are the result of the process of teaching and learning in education for sustainable development.

6. Empirical Research

The present empirical study was conducted during the implementation of English for Academic Purposes studies in the *English for Academic Purposes* course within the master programme *School Management* of Riga Teacher Training and Educational Management Academy in 2008-2009. Students' communicative competence is the outcome of the process of teaching and learning within English for Academic Purposes studies. Interpretative research paradigm which corresponds to the nature of humanistic pedagogy (Lūka, 2008, p. 52) has been determined. Moreover, the researcher is the interpreter. Interpretative paradigm is characterized by the researchers' practical interest in the research question (Cohen, Manion et al., 2003). The research question is as follows: has the process of teaching and learning influenced the development of students' learning outcomes?

An explorative research aimed at developing hypotheses, which can be tested for generality in following studies (Mayring, 2007, p. 6) has been used in the empirical study (Tashakkori, Teddlie, 2003). The study consisted of the following stages: *analysis of the students' learning outcomes – students' communicative competence - in the pre and*

post-survey, data processing, analysis and data interpretation, analysis of the results and elaboration of conclusions and hypothesis for further studies.

The qualitatively oriented research allows the construction of only few cases (Mayring, 2007, p. 1). Moreover, the cases themselves are not of interest, only the conclusions and transfers we can draw from this material (Mayring, 2007, p. 6). Selecting the cases for the case study comprises use of information-oriented sampling, as opposed to random sampling (Flyvbjerg, 2006, p. 229). This is because an average case is often not the richest in information. In addition, it is often more important to clarify the deeper causes behind a given problem and its consequences than to describe the symptoms of the problem and how frequently they occur (Flyvbjerg, 2006, p. 229). Random samples emphasizing representativeness will seldom be able to produce this kind of insight; it is more appropriate to select some few cases chosen for their validity. Thus, the present empirical research involves 12 respondents: two researchers and educators in the field of language pedagogy, and a sample of 10 first year master students.

The students' group consisted of eight females and two males which is a typical representation to the proportion of female and male students in school management in Latvia. The age of the sample was from 23 to 48. The students represent different upbringing backgrounds and diverse educational approaches. All 10 respondents had certain expectations from the master programme and, consequently, from the *English for Academic Purposes* course, which were demonstrated in the answer to the question why they had chosen to participate in this study. Use of communicative competence in the studies was one of the answers. English is a foreign language for all the students in the group. In accordance with the students' self-evaluation based on the levels of the self-assessment grid of the *Common European Framework of Reference for Languages: Learning, Teaching, Assessment* (Council of Europe, 2001, p. 26): two students reached Level A2, three students had Level B1, one student obtained Level B2 and four students took Level C1. The students' mother tongues considered to contribute to the successful foreign language learning and to become an instrument of bringing the students together more closely under certain conditions - appropriate materials, teaching/learning methods and forms, motivation and friendly positioning of the language educator (Abasheva, 2010, p. 431) - are as follows: Latvian - for seven students and Russian - for three students. The sample is multicultural as the respondents with different cultural backgrounds and diverse educational approaches from different parts of Latvia, namely, Kurzeme, Vidzeme, Zemgale and Latgale, were chosen. That emphasizes the study of individual contribution to the development of students' communicative competence within English for Academic Purposes studies (Lūka, Ludborza, Maslo, 2009, p. 5). What seems very positive is that the students are willing to learn languages. All the students had indicated that they had participated in the *English* course in order to get experience of learning English. Hence, the group's socio-cultural context (age, field of study and work, English level, mother tongue) is heterogeneous.

Methods of data gathering included internal evaluation (Hahele, 2005). Internal evaluation is provided by internal evaluators (Hahele, 2005, p. 40) - students and educators of the educational institution (Hahele, 2005, p. 41). The pre-survey and post-survey of the students' communicative competence comprised the following methods: students' self-evaluation (a student him/herself) and evaluation of students (English educators). The pre-survey's results of the students' communicative competence in the *English for Academic Purposes* course in September 2008 allow drawing the conclusion that the low level of the students' communicative competence dominates in the English for Academic Purposes group.

The professional master programme "School Management" of Riga Teacher Training and Educational Management Academy comprises English for Academic Purposes course. English for Academic Purposes in Latvia relates to Level 7 among 8 educational stages of the European Qualification Framework (Martyniuk, 2006, p. 16). Level 7 is defined by a set of descriptors indicating the learning outcomes relevant to qualifications at that level in any system of qualification (European Qualification Framework, 2006, p. 19):

- **knowledge:** highly specialized knowledge, some of which is at the forefront of knowledge in a field of work or study, as the basis for original thinking; critical awareness of knowledge issues in a field and at the interface between different fields;
- **skills:** specialized problem-solving skills required in research and/or innovation in order to develop new knowledge and procedures and to integrate knowledge from different fields;
- **competence:** manage and transform work or study contexts that are complex, unpredictable and require new strategic approaches; take responsibility for contributing to professional knowledge and practice and/or for reviewing the strategic performance of teams.

Riga Teacher Training and Educational Management Academy provides the *English for Academic Purposes* course to facilitate students' research success, to support preparation for international Ph.D. programmes in the European Union, to promote further specialization in the chosen field and learning in a simulated environment. The aim of the *English for Academic Purposes* course is to improve students' communicative competence in English for Academic Purposes for the participation in international research activities. The objectives of implementation of English for Academic Purposes studies in the *English for Academic Purposes* course are to widen students' social experience - experience in social interaction and cognitive activity. Implementation of the process of teaching and learning within English for Academic Purposes studies comprises three phases:

Phase 1 *Teaching* is aimed at a safe environment for all the students. In order to provide a safe environment, the essence of constructive social interaction and its organizational regulations are considered by the educator and students. The present phase is organized in a frontal way involving the students to participate: The educator makes previous experience rational. The activity includes choice of forms and use of resources that motivates the students.

The teaching process is under the educator's guidance. The peers do not participate in guidance of the teaching/learning process. The activity is carried out qualitatively only with the help of the educator. Dependence on the educator is observed. The students study alongside but not together. The students create the system of the aim and objectives, search for a variety of information source and obtain techniques of information compiling. The students fulfil the activity qualitatively only with the educator's help. Dependence on the educator is observed, not dependent on the peers.

Phase 2 *Peer-Learning* is designed for the students' analysis of an open academic problem situation and their search for a solution. The same materials can be prepared for all of the group students. This phase involves the students to act in peers: The educator functions as a resource and moderator. The educator delegates his/her duties to the students. The peers regulate each other: it is typical for students to regulate each other. The students study together, study from others and teach others. The teaching/learning process is under the peer's guidance. The activity's forms and methods are exchanged. The students fulfil the activity qualitatively with the peers' help. Partial independence is observed. The relevant activity is performed jointly with other students and with shared responsibility.

Phase 3 *Learning* emphasizes the students' self-regulation with use of assessment of the process and self-evaluation of the results: The educator functions as a consultant and an assistant. The educator delegates his/her duties to the students. The peers have consultative and advisory functions. Students' self-regulation is typical. The students study independently. The students fulfil the activity qualitatively in an autonomous way, and their independence is observed. The participants' self-regulation on the basis of the process assessment and the result self-evaluation is used. The relevant activity is performed with a high sense of responsibility. Self-regulation is typical, and a student does not depend on peers.

In order to determine the developmental dynamics of each student's communicative competence, comparison of the pre-survey and post-survey results of each student's communicative competence was carried out. The comparison revealed that the students' communicative competence had increased to nine students as demonstrated in Figure 8 where the vertical numbers mean six levels of students' communicative competence, the horizontal numbers present the code number of the students who participated in the pre- and post-surveys, Code CC1 shows the pre-survey's results of the students' communicative competence and Code CC2 presents the post-survey's results of the students' communicative competence. The post-survey's results demonstrate the optimal level of the students' communicative competence.

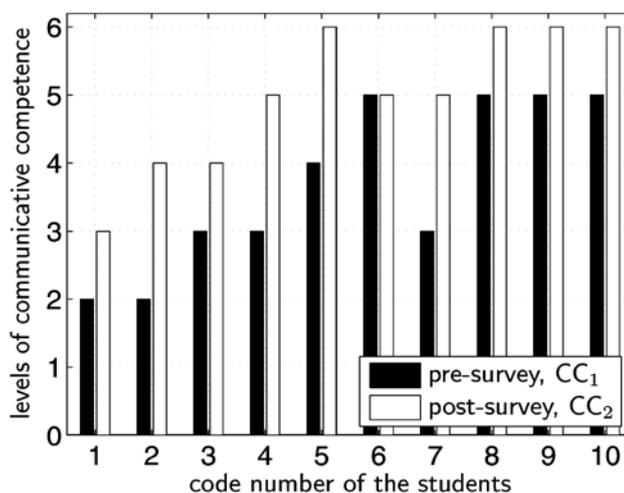


Figure 8: Inter-connections of the pre-survey and post-survey between levels of each student's communicative competence

Finally, the *Mean* results of the descriptive statistics show that the level of the students' communicative competence has positively changed as presented in Table 1.

Table 1: Mean analysis of the pre- and post-surveys

Outcome criterion	Mean in the Pre-survey	Mean in the Post-survey
Students' communicative competence	2,48	4,83

Hence, considering judgment to be part of the art of statistics (Gigenzer, 2004, p. 603), the conclusion has been drawn that the process of teaching and learning within English for Academic Purposes studies influenced the

development of the students' communicative competence demonstrated by the difference between the levels of the students' communicative competence in the pre- and post-survey.

7. Conclusions

The empirical findings of the research allow drawing the conclusion that the process of teaching and learning in education for sustainable development has influenced the development of students' learning outcomes. The results of theoretical and empirical research allow modelling the process of teaching and learning in three phases: teaching in Phase 1, peer-learning in Phase 2, learning in Phase 3. Therein, a hypothesis has been put forth: the process of teaching and learning in education for sustainable development influences the development of students' learning outcomes if students are provided with personal experience in the process of teaching and learning. Regarding the term *perspective* as "to embody certain fundamental assumptions" (Barry, 2002, p. 3), perspectives of game theory in education for sustainable development are determined as following:

- What economists call game theory and psychologists - the theory of social situations (Levine, 2011, p. 1), pedagogues call the theory of teaching and learning.
- The pedagogic strategy of decision-making for sustainable development includes the process of teaching and learning.
- The process of teaching and learning in education for sustainable development proceeds from teaching in Phase 1 through peer-learning in Phase 2 to learning in Phase 3.
- The participants of the process of teaching and learning are educators and students. Therein, by educators teachers are meant, by students – learners, by peers – a small-size group of students.
- The process of teaching and learning depends on participants' (the educator and students in the present research) choices that affect the interests of the other participants (Turocy, Stengel, 2001, p. 2) as presented in Table 2.

Table 2: Participants' choices in the process of teaching and learning

Participants	Teaching	Peer-learning	Learning
Educator	The educator makes previous experience rational. The activity includes choice of forms and use of resources that motivates the students. The teaching process is under the educator's guidance.	The educator functions as a resource and moderator. The educator delegates his/her duties to the students.	The educator functions as a consultant and an assistant. The educator delegates his/her duties to the students.
Peers	The peers do not participate in guidance of the teaching/learning process. The activity is carried out qualitatively only with the help of the educator. Dependence on the educator is observed. The students study alongside but not together.	The peers regulate each other: it is typical for students to regulate each other. The students study together, study from others and teach others. The teaching/learning process is under the peer's guidance. The activity's forms and methods are exchanged.	The peers have consultative and advisory functions. Students' self-regulation is typical. The students study independently.
Student	The students create the system of the aim and objectives, search for a variety of information source and obtain techniques of information compiling. The students fulfil the activity qualitatively only with the educator's help. Dependence on the educator is observed, not dependent on the peers.	The students fulfil the activity qualitatively with the peers' help. Partial independence is observed. The relevant activity is performed jointly with other students and with shared responsibility.	The students fulfil the activity qualitatively in an autonomous way, and their independence is observed. The participants' self-regulation on the basis of the process assessment, and the result self-evaluation is used. The relevant activity is performed with a high sense of responsibility. Self-regulation is typical, and a student does not depend on peers.

The present research has *limitations*. The inter-connections between education for sustainable development, game theory, development of the system of external and internal perspectives, social situation and the process of teaching

and learning have been set. A limitation is the empirical study conducted by involving educators and students at master level of one tertiary institution. Therein, the results of the study cannot be representative for the whole country. Nevertheless, the results of the research – phases of the process of teaching and learning, the methodology of development of the system of external and internal perspectives, English for Academic Purposes studies and the explorative research design - may be used as a basis of the development of students' communicative competence at master level of other tertiary institutions. If the results of other tertiary institutions had been available for analysis, different results could have been attained. There is a possibility to continue the study. Further research proposes to analyze efficiency of implementation of the teaching and learning process in education for sustainable development. Another direction of further analysis is considered as implementation of the teaching and learning process in five phases: teaching in Phase 1, teaching with elements of peer-learning in Phase 2, peer-learning in Phase 3, peer-learning with elements of learning in Phase 4 and learning in Phase 5.

Further research could include analysis of principles of organization of the teaching and learning process in education for sustainable development. Thus, the present paper provides theoretical contributions on game theory in education for sustainable development.

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ПЕРСПЕКТИВЫ ТЕОРИИ ИГРЫ В ОБРАЗОВАНИИ ДЛЯ УСТОЙЧИВОГО РАЗВИТИЯ

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Аннотация

Устойчивое развитие общества вызвало огромный научно-исследовательский интерес. Стратегический аспект эволюции общества исследуется теорией игр (Фернандес, 2011, с. 1). Вопрос исследования заключается в следующем: как организовать процесс преподавания в образовании для устойчивого развития? Целью исследования является моделирование процесса преподавания в образовании для устойчивого развития. Анализ включает в себя процесс анализа смысла ключевых понятий «образование для устойчивого развития», "теория игр", "социальная ситуация". Кроме того, исследование демонстрирует, как ключевые понятия связаны с идеей "процесса преподавания". Эмпирическое исследование было проведено в рамках курса "Английский для академических целей" в Рижской академии педагогики и управления образованием в 2008-2009 гг. В эмпирическом исследовании участвовали 10 респондентов. Результаты исследования позволяют смоделировать процесс преподавания в образовании для устойчивого развития. Направления дальнейших исследований предложены.

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