

Constructivism and its Application in Integrated Concept of Science Education

Description of the project

The current situation in research field

The paradigm of the constructivism theory starts to infiltrate into the thinking process of science education and that is documented by increased publishing activity especially in Anglo-Saxon and Germanic literature. In our pedagogical literature some works concerning this issue seem to appear concerning, but only in little number in the field of scientific education. The perception of cognition as a construct activity relates both to cognitive activity of a pupil and to a teacher of science subjects or researches in the didactics fields of science subjects. The fundamental resource is comprehension of scientific vision and students' conception (preconceptions) as an equal sources for reconstruction the content structure. The way of assertion relationships between pupil's cognition and the scientific vision is crucial factor in constructivist oriented approach. In this approach the academic positions are understood as content cognition and are components of everyday visions of pupils' as personal structure particular individuals. Pre-concepts are not viewed as mistaken (misconcepts) in respect of academic concepts, but they are viewed as equal sources for construction of education. The didactics reconstruction of these pre-concepts arises from an effort to create meaningful instruction and research of instruction in the field of scientific education. The acquisition of knowledge from particular scientific subject is involved (1) by pre-concepts with which students come to education and (2) by their social and material conditions for the actual realization of the education. Pre-concepts are single characteristics of learning individual and are created by all other influences and experiences that had any connections with them. All other aspects have very important role during the creating of it. These are exogenetic factors (social, economical, ethic, cultural etc.) and endogenic factors that come from psychological and psychosocial characteristics of each individual. The research of these concept changes is the basic conception of constructivist scientific education.

Field didactics as disciplinary domain have been stagnating in our countries for some time. The attention is concentrated on creation of new curricular material although there have been no real focuses on development these disciplines for long time period. No deeper analysis of the current state of cognition process has been done in science education. With increasing possibilities of international communication the question of construction science education becomes more apparent.

The current clear traditional approach towards instruction at school is characterized by dominant status of the teacher, receptive passivity of pupils. The scientific findings are acquired in a form that excludes their later application and utilization. The pupils can not use their knowledge in concrete situations because they can not recognize their relation to the reality. They can not transfer their experience to the real situation. One of the possible ways how to gain active knowledge is constructive approach to the instruction of scientific subjects. In this approach the present instructive teaching practice is completed by chosen learning problems through creating adequate learning environment. First of all, a pupil matches new knowledge with his/her experience and view to world. This process is individual, relative and unpredictable. The teacher's goal must form rich and communicative setting in content that will address the subjective field of experience and at the same time will include new problems

that will attract to creative self-orientation. The mastery of a teacher lies in the fact that he/she can predict the chain of sequences between former situation constructions at a pupil and scientific knowledge which are taken by the pupil as a state of expected clash and sorts out and overrule by the way of tests and errors. In the environment the individual has the subjective extent of knowledge and experience.

During the model creation it is necessary to know that knowing is not closed, it is forming – it constructs itself individually and in terms of social relationships. Learning is an active process, it realizes in multidimensional relationships. From this perspective the learning process is primarily the matter of construction, learning individuals enter as co-creators of learning process. The results of learning are not predictable. We always come out from the existing construction knowledge. The function of the tutor is to lead the subject to objective adoption of already existing construction and that is given by easy reach and the transfer knowledge. The goal is learning that is always constructive, the goal of instruction must be to enable the pupils to create the constructions. This is an individual building up of multiform relationships that in its network will create the structure of knowledge for application in further contexts and social contacts.

The fact is that during the instruction of science subjects in the schools the traditionalistic approach prevails and in where the knowledge transmission by the teacher in ready form plays the crucial role and in which the activity of the pupils is minimal and the emphasis is put on memorizing. The teacher is the source of transferred information. It is natural that nowadays this model is untenable. However, the field didactics dedicated little attention to this area. The field didactics do stagnate in the last decade. We consider to re-establish their academic potential and to focus on application of current pedagogical theories to the area of science education and to succeed its quality and to increase the interest in science subjects not only for pupils but also for the future teachers of these subjects.

Following suggestions come from these premises:

- The interdisciplinary conception of science, there is an idea of the world in the middle of it. The world is not depended on the interpretation of individuals who life in it.
- The objective reality is encounters the subjectively constructed and interpreted reality and their connection in process of communication.
- Purely biological, physical or chemical do not exist.
- The natural construction of terminology in the pupil's thinking.
- Gradual formation of logical structure of knowledge.
- The strategy of learning, cognition and interpretation.
- The internal understanding based in personal and social competences of a pupil.

The field didactics have deep tradition at Faculty of Science of Palacky University in Olomouc. In the view of good personal and material equipments there are very good conditions for further improvement and development of academic work in field didactics. This project is in harmony with long period intentions of the Faculty and it is supported by the council of the Faculty.

The goals of the project

The basic goal of the project is to develop constructivist approach towards the area of the theory of Physics, Chemistry and Biology and to increase the academic-research potential of particular field didactics. The main goal will be realized in following specific goals:

- To extend the theoretical basis of the field didactics;
- To contribute towards development of the didactics of Physics, Chemistry and Biology and mostly in methodological spheres;
- To increase the level of pedagogical research in field didactics;
- To contribute to contextual, formal and terminological compatibility of research in field didactics;
- To implement pedagogical researches that will contribute toward increase of research prestige within academic community and that will contribute to improvement of science subjects' instruction at schools;
- To enrich non-standard approaches in the research and to enrich Pedagogy as a science;
- To apply constructivism into appropriate area of field didactics;
- To realize terminological content analysis of Physics, Chemistry and Biology at primary schools;
- To define basic terminology of integrated instruction for science subjects;
- To realize the research of pre-concepts of pupils of primary schools from acquired databases of integrated instruction;
- To characterize the watched concepts with a help of cognitive and affective dimension and to localize them in the cognitive map of a pupil;
- To create a model of perspective didactics system of integrated instruction of Physics, Chemistry and Biology at primary school;
- To specify the goals in this system, the content, methods and forms of instruction and evaluation of instruction;
- To create a databank of simple experiments supporting constructivist approach and to create didactics system of integrated instruction of Physics, Chemistry and Biology at primary schools.
- To realize the analysis of possibilities of interdisciplinary terminology construction in science education;
- To form the practical suggestions and stimulation for application results of individual approaches in educational process and transformation didactics into instruction projects.

Conceptual and methodical approaches

In the field of theoretical study there will be used mostly analysis, synthesis and comparison. These analytical, synthetic and comparative approaches will enable the basic theory of constructivism in the scientific knowledge. The goal in the area of research of pupils' pre-concepts is to gain the knowledge about the individual understanding of some integrating terms in the Physics, Chemistry and Biology instruction. The subject of the research is cognitive, affective and psychomotor components of chosen pre-concepts; these goals can be implemented through qualitative and quantitative methods of pedagogical research (interview, discussion, observation, questionnaires and case studies). During the evaluation of some pre-concepts the method of semantic differential and projective method will be used. On the basis of the realized research, analysis, synthesis and comparison of foreign project the system of main integrating terms, principles and theories will be suggested. The analytical and synthetic methods will lead to creation of integrated of didactics system. The content analysis will enable the goal definition, content and the evaluation of didactics system. The created didactics system will enable transformation into instruction projects integrated scientific

education. With the use of modeling the model of pre-gradual preparation of teachers for integrated instruction of scientific disciplines will be suggested.

The timing

We suppose the start the work on the project in January 2005 and the end of project in 2008. The work will be done in 6 stages.

Stage	Time period	Actions
I. Initial phase	January 2005-September 2005	The study of literature and foreign projects, terminology analysis, definition of basic terminology.
II. Pedagogical research	September 2005-February 2006	The research of pre-concepts and their interpretation, characteristics of pre-concepts.
III. The creation of didactics system of integrated instruction of scientific subjects.	March 2006- September 2006	The definition of goals, content and the methods of evaluation of didactics systems.
IV. Verification	October 2006-January 2007	Reviewing the suggested projects, meeting with the experts and the teachers, correction in didactics systems of integrated instruction.
V. The transformation of didactics system into instruction project.	February 2007-September 2007	The definition of pupil's competencies. The creation of additional materials for didactics project of integrated instruction.
VI. Model of pre-gradual preparation of teachers for integrated instruction.	October 2007-October 2008	Application of constructivism into professional preparation of teacher of integrated instruction of scientific subjects.

Outcomes of the project

- Theoretical study of Constructivism and instruction of science subjects.
- Research of chosen pre-concepts at primary schools.
- Databank of basic terminology in instruction of science subjects.
- Study Integrated approach of instruction of science subjects at primary schools.
- Didactics system of instruction of science subjects at primary schools.
- The set of supportive materials for transformation of didactics model of instruction of science subject into practice.
- Scientific seminars and discussions (3)
- Presentation on home and foreign conferences (8)
- Publication activity (1 monograph, articles in magazines).

The importance of the project for the theory and practice of science subjects

The suggested research has not been in particular field didactics realized yet. It will contribute towards understanding of basic terminology of individual didactics for students and for creation of basic terminology and symbolic words, which will help to create integrated didactics system. This integrated model has no deep tradition in our country. But in other countries there are obvious tendencies towards to integration of scientific education. In many countries this model is successfully realized especially in primary level. Integrated and at the same time coherent didactics model of science subjects abolishes the diversity of knowledge and simplify their transfer and the processes of education. It will increase the content understanding of science concepts, rules and theories and their application in modern technologies. It will create the space for the methods supporting individual and creative activity of pupils and increase the quality and effectiveness of instruction. The created didactics project of integrated instruction of Physics, Chemistry and Biology will be the first project of this type in the Czech Republic. We have no experience whatsoever with this approach and therefore it will be the initial research project. It will enable the transformation into integrated instructional projects. It reflects the demands of teachers in practice and it will make the curricular material development easier. The research in the area of science subject will strengthen field didactics academically and will enable counter connection of Physics, Chemistry and Biology, but also the connection with Pedagogy.

Awareness of the working team

All members of the working team are professional, they have adequate experience and pedagogical knowledge and they can guarantee the success of this project. In the solving team we have these people: 1 professor in the field of Pedagogy, 1 associate professor in the field of Pedagogy, 1 associate professor in the field of Chemistry Didactics, 1 associate professor in the field of Physics Didactics, 1 associate professor in the field of (Botany) – he is specialized in teaching didactics of Biology and he has been doing it for many years. And we have also candidates of science of in the didactics of Chemistry and Physics and 1 specialist in Psychology. The ratio of lectures and field didactics will guarantee the tight connection of Pedagogy and the field didactics.

The field didactics have an established tradition at the Faculty of Science of Palacký University. The department of Experimental Physics besides of education of new teachers is engaged with other activities in the area of Physics education. New textbooks of Physics, the collection of Physics exercises and other study material are created at this department. A brand new collection of Physics instructions instruments was created here including new instructional films and video programs. The research in the area of Physics education is focused mainly on the needs of schools in the field, on further education of the teachers of Physics at all types of school and on the development of Physics, Chemistry didactics as a theoretical discipline. The department is the seat of the editor's office for the nation-wide magazine for the teachers of Mathematics – Physics – Informatics. The work place has a long-term cooperation with FPS JČMF, ČŠI, MŠMT, centers of Pedagogy and the teachers of Physics at all schools systems.