Research projects

J5-5535 (B) – Development of information literacy of university students as a support for solving authentic science problems (basic research project) (1.8.2013 - 31.7.2016)+

http://sicris.izum.si/search/prj.aspx?lang=eng&id=8666&opt=1

ABSTRACT

For the success of individuals and society as a whole, in particular three key competencies are needed in the twenty-first century: the ability to use new emerging technologies, to participate in a process of lifelong learning, and to select relevant information from large data sets. In order to facilitate problem solving skills, a new vision of scientific literacy is needed, which integrates scientific literacy and information literacy (IL), with up-to-date information and communication technologies. An important contribution towards the uniformity of IL in higher education institutions is the introduction of standards and criteria developed by renowned organizations, such Information Literacy Competency Standards for Higher Education, with authorized Slovene translation.

Despite the efforts made to integrate IL standards into higher education, students are often developing IL skills superficially, without the ability to use them in solving authentic problems in their specific academic fields. IL competences and skills often remain at lower cognitive levels, which does not permit the application of higher cognitive categories of knowledge, such as the use of knowledge, analysis, synthesis and evaluation – the levels that are necessary to solve real problems in the face of multidisciplinary challenges.

In an effort to deepen and expand IL skills beyond a general perspective, the project group will develop and evaluate a new educational model (PBL-IL), suitable for upgrading the IL of students in university science programmes. The model will integrate IL competency standards into problem based learning (PBL), and it will be implemented on a selected learning management system, such as Moodle or Sakai. To achieve this objective, the project foresees the following tasks: (1) determination of the IL and scientific literacy of students at the beginning of their university courses, (2) development of a new PBL-IL model, designed by the integration of IL competency standards into a PBL approach, (3) implementation of the PBL-IL model in a suitable e-learning environment, and the preparation of original e-learning materials, adapted to the students' fields of study, (4) monitoring and evaluating the impact of the PBL-IL model on students' success in solving problems, their self-efficacy, motivation, and self-concept, (5) identification of key elements of the PBL-IL model which influence the performance of students in solving problems, (6) development of new concepts in education by applying the PBL-IL model, (7) generalisation of the PBL-IL model, and the development of proposals for effective implementation of PBL-IL in the global higher education area.

Well-developed scientific information literacy, obtained through solving authentic study problems, will better qualify students for solving real life problems. We also expect that in the long-term, scientific IL will contribute to improved study results, increase the employability of graduates, and shorten the average duration of study, which in Slovenia is still too long, resulting in a loss of intellectual potential in the years when human creativity is usually at its highest. The designed PBL-IL model and e-learning materials will be available to students and professors of education, informatics, and science subjects, and to librarians at university libraries, as model

examples of teaching units, which could be used in their own educational materials for the enhancement of students' scientific IL.

The project will be implemented in cooperation of the Faculty of Natural Sciences and Engineering, Biotechnical Faculty, and Faculty of Education at the University of Ljubljana; Faculty of Natural Sciences and Mathematics and Faculty of Organizational Sciences at University of Maribor, and Faculty of Information Studies in Novo mesto. All together 12 highly qualified researchers from complementary research disciplines will cooperate in the project realization.

L2-5571 (D) – New materials for printed sensors and indicators and their integration in smart printed matter (applied research project)+

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ABSTRACT

Smart printed matter is a product of graphic technology, which will remain despite of full introduction of information technologies. It is a synthesis of printed electronics with indicator materials and advanced graphic design. The variability and uniqueness of smart printing matter is subject to these three mentioned fields. Indicator materials have to response to external factors in a repeatable and controllable manner. Their most important feature is a clearly visible and easily recognizable colour change. Printed sensors detect the external factors electrically, which allows communication with other electronic equipment. However, they usually do not combine chromogenic effects and remain therefore invisible to the customer. Active combination of indicator materials, printed electronics and appropriate graphic design allow combining these features to a new product called a smart printed matter.

Organic and mixed composites predominate among the chromogenic indicator materials. Their properties depend on several external factors simultaneously, e.g. temperature, UV radiation and pH of the surroundings. We will develop new indicator materials and/or improve the existing ones so that only one of the external factors will dominate and its effects will be repeatable within certain region of interest. Some of these materials will be developed and used for printed indicators, which change colour in accordance with temperature, thermal history or UV radiation.

Indicator materials will be microencapsulated to work properly also in the non-isolated environments. For this purpose we will take into consideration the required flexibility of the microcapsule's polymeric shell, its non-permeability for the core material, the optimal thickness, the appropriate light transmittance and the mechanical and thermal stability. Additional functionalities will be introduced by proper selection of materials applied for polymeric shell and its further modification. Such microcapsules are the so-called multifunctional pigments, which, together with an appropriate binder, will be applied in multifunctional printing inks. These inks will be used further for printed functionalities.

Printed electronics is capable of producing significantly bigger sensors than conventional microelectronic technology. Resistance-based sensors that measure the absorption of the analyte through the change in resistance, and capacitive sensors, which detect this by changes of the dielectric constant of the sensor layer, will be printed. The changes of electric properties of sensor layers will be controlled also by chromogenic inks

to provide the corresponding visual perception. We will also explore the possibility to print 3D freestanding structures, such as electro-thermal actuator. Printing offers advantages of large dimensions that such devices need for good functioning.

The smart printed matter will be prepared by combining indicator materials, multifunctional printing inks and printed electronics with special methods of security printing in advanced graphic design. It will be able to protect the packaging against counterfeiting, provide consumers with additional and easily recognizable information about the product and allow appropriate electronic communication. The proposed project will open up a new area dedicated to developing suitable combinations of printed electronics, indicator materials, security printing and advanced graphic design.

J5-6814 (C) – Explaining Effective and Efficient Problem Solving of the Triplet Relationship in Science Concepts Representations (basic research project)+

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ABSTRACT

The research projects' aims are to explain participants', with different science knowledge, especially chemical concepts at three levels of representation, science problem solving strategies. Presentation of the triple nature of science concepts is in chemical education research an important field of research, nationally and internationally, in the last thirty years. Three levels of concept representation are based on the fact, that it is possible to represent science concepts by the experimental work or observation of the phenomena (macroscopic level), by the interpretation of the observations at the level of interactions between the particles (submicroscopic level) and at the level of records of interpretations with different symbols with specific meanings (symbolic level). An individual's ability to solve specific science problems depend on integrative understanding of all these three levels. For interpretations of these strategies to solve authentic science problems various techniques of data collection, from those in the field of education less classical and applied in cognitive science (e.g. eye-tracker, psycho-physiological parameters, audio-video recording), to those that are more standard in science education research (questionnaires, tests and knowledge tests), will be applied. Since it is impossible to unambiguously clarify the complex cognitive processes, it makes sense to use a triangulation of data collection techniques and also more complex data analyze. From these results it would be possible to accurately infer the ongoing cognitive processes in certain mental activities. Based on the findings of empirical research, which will also include analysis of teachers' teaching strategies of triple nature of chemical concepts in primary and secondary school and subject-specific competences of teacher education, teaching and learning model of the triple nature of the chemical processes at all levels of schooling, will be constructed. These results would also allow the development of specific learning modules of selected science topics, not only in chemistry, but also in biology and physics, which reflect the triple nature of chemical concepts. Research results, guidelines for teaching and learning of the triple nature of chemical concepts and developed modules will be the basis for the preparation of monographs and other scientific national and international publications.