MODULAR APPROACH TEACHING SYSTEMS BIOLOGY TO MONODISCIPLINARY SPECIALISTS IN THE EUROPEAN PROJECT 'MOSBIO'

EGILS STALIDZANS, IVARS MOZGA

Biosystems Group, Department of Computer Systems
Faculty of Informmation Technology
Latvia University of Agriculture

Abstract

Recent great achievements of biology - complete sequencing of genomes of several organisms gave us huge amount of knowledge about biomolecules. Implementation of new achievements was very promising. Still there exist uncured diseases and unsolved items in different bioeconomy branches.

Systems Biology (SB) is a science that discovers the principles underlying the emergence of the functional properties of living organisms from interactions between macromolecules.

Fast development of SB is determined by its high value in technology intensive bioindustries (medicine, biotechnology, food industry) and ecology (sustainable development, biofuels).

EU Life Long Learning program Transfer of Innovation project 'MOdular education for interdisciplinary Systems BIOlogy' (MOSBIO) has to contribute the delivery of scientific progress to the industry (Science->Education->Implementation) as well as distribute the expertise of most developed countries to the rest of EU.

Main idea of the project is to split SB competence in a number of educational modules to allow target oriented individualised vocational education of managers, technologists, scientists and teachers as the main groups of beneficiaries.

Expected results of the project are: definitions of educational modules, contents of educational modules, MOSBIO website, pilot courses (to get the feedback about modules) and MOSBIO conference.

Partnership consists of 6 partners from 5 countries (Latvia, Germany, Estonia, Finland and Spain) representing 3 universities, 2 SME and 1 professional association.

Keywords: *systems biology, interdisciplinarity, modular education,*

Introduction

Recent great achievements of biology - complete sequencing of genomes of several organisms gave us huge amount of knowledge about biomolecules. Implementation of new achievements was very promising. Still there exist uncured diseases and unsolved items in different bioeconomy branches.

Actually we know quite a lot about components of living organisms. Still we do not know how they interact and how interacting molecules create living forms! The same problem we would face having all the components of a radio without knowledge how they have to be interconnected to hear a radio transmission (Lazebnik 2002). On the other hand successful connection of components would be a proof that components and their interaction principles are well understood thus allowing correct diagnostics and repair. Systems Biology (SB) is trying to understand the working principles of living beings to get skills to repair or modify them (Palsson 2000).

One of SB definitions: SB is a science that discovers the principles underlying the emergence of the functional properties of living organisms from interactions between macromolecules (Alberghina and Westerhoff, 2005).

Fast development of SB is determined by its high value in technology intensive bioindustries (medicine, biotechnology, food industry) and ecology (sustainable development, biofuels) (Alberghina and Westerhoff, 2005; Klipp et.al. 2006).

One of preconditions of fast and effective SB development and implementation of its results in industry is the interdisciplinary collaboration of specialists from different non-related groups of branches: biology, medicine and chemistry (live experiments, biological interpretation), information technology (data handling, modelling, software development, development of control systems), mathematics and physics (modelling, data processing) and others (Reiss, 2005). Interdisciplinary collaboration has to lead to a synergy in highly technological industry and economy. Still interdisciplinary collaboration requests interdisciplinary education.

There are different experiences of interdisciplinary education in systems biology and bioinformatics: technical educational institutions have trained engineers and information technologists towards biology and the way around. That experience can be combined with training methods of vocational education that are specific if the trained people are high level specialists in one of the fields and a beginner in another one. Modular education system can be adapted to particular needs of a monodiscipline specialist can contribute to the above analysed educational problem.

This article describes the approach of the EU Life Long Learning program Transfer of Innovation project 'MOdular education for interdisciplinary Systems BIOlogy' (MOSBIO) solving interdisciplinary education problems of Systems Biology (SB) using modular structure of education.

MOSBIO partnership and background

MOSBIO project is funded by Lifelong Learning programme *Leonardo da Vinci* of European Comission. It has started 1-st November 2007 and last for 24 months. MOSBIO web site is *www.mosbio.eu*. Partnership consists of 6 partners from 5 countries representing 3 universities, 2 SME and 1 professional association. Partners are: Latvia University of Agriculture from Latvia (senior researcher Egils Stalidzans), University of Rostock (Prof. Olaf Wolkenhauer) from Germany, University of Tartu from Estonia (Prof. Maido Remm), SME Medicel Oy (PhD Christophe Roos), SME Noray Bioinformatics SLU (Julio Font) from Spain and Latvia Association of Biotechnology (Dr.sc.ing. Juris Vanags) from Latvia. Coordinator of the project is Latvia University of Agriculture.

Current position in European SB indicates the background and aims of MOSBIO as a transfer of innovation project.

1. There is different level of systems biology and biotechnology development in different countries involved in the project. The highest level of development can be observed in Germany, Finland and Spain. Systems Biology in Latvia and Estonia is at the moment not that well developed in terms of funded projects and education possibilities. EU generally lags USA and Japan both in aspects of science and implementation (Reiss, 2005). There are intentions to improve EU position and it can be clearly seen in the priorities of FP7.

2. Another problem is the need to implement newest scientific achievements in the industry to increase international competitiveness of EU and develop highly technological approach of bioindustry thus getting new interest and financing from industry for scientific developments creating a sustainable cycle of interaction. This activity requires also knowledge and readiness for interdisciplinarity from industry representatives on different level: managers, technologists, research and development specialists as well as education possibilities.

3. Different parts of SB achievements can be used in many industries and main objectives and specific knowledge for a particular industry have to be prepared and explicitly explained to the representatives of industry without previous specific knowledge.

Fundamental analysis of current position is done in the report of FP6 project "The Take-off of European Systems Biology (EUSYSBIO), Workpackage 1. Systems Biology is recognised as highly perspective high technology interdisciplinary field with very wide expected impact covering fields from ecology to medicine (Reiss, 2005).

Aims and objectives

In the project are involved both the most developed and less developed countries in terms of SB development and implementation. Thus innovation transfer covers all the spectrum of needs for all the other countries as well as educational modules and other results will be made available.

Project has to contribute the delivery of scientific progress to the industry (Science->Education->Implementation). Therefore the project partners represent all the groups involved: scientific institutes, universities, professional associations and industry representatives. Project address needs of specific groups including managers to stimulate financing of industry related scientific activities also by industry.

Cross-industrial transfer of innovative methodologies is assured by participation of organisations related to different specialists and fields of SB application: medicine, biotechnology, food industry, ecology, bioenergetics.

Types of transfer

Innovative potential of Systems Biology is mostly developing in the sector of medicine as high financing potential for healthcare is available from governmental and business institutions. Additional factor is the faster development of SB in more developed countries.

Project aims to transfer innovation in both sectoral and national dimensions.

1. Advanced methods and technologies used in healthcare can be used in ecology, food technology, different areas of biotechnology, agriculture, bioenergy because of relation to materials of biological origin. Project aims to collect, exchange and spread knowledge between mentioned branches.

2. International and territorial transfer of innovation will be achieved by highly international team covering different areas of EU (5 countries) and publishing educational modules on the Web and other media.

Target groups of modular education

1. Managers of industrial and scientific organisations have to know the main ideas of Systems Biology to stimulate exploitation of the new interdisciplinary science in particular field of activity. Managers are educated in just one field relevant to SB or just business sciences. They have to get rough overview about interdisciplinary SB.

2. Technologists depending on their background and branch of industry have to get lacking modules of knowledge to be able to think and act interdisciplinary at least being able to communicate with SB specialists with background in different field and see the perspective of collaboration.

3. Scientists entering cross disciplinary field need overview about the field of Systems Biology as well as structured educational materials. That can increase the value of researcher in a widely scientific branch.

4. Teachers are important target group. They increase their own value as well as contribute to the valorisation of the project results.

Potential users

Potential users are industrial and research organisations being able to increase their technological advance in knowledge based industrial branches due to technological knowledge.

Depending on fields of SB applications beneficiaries is all the society due to optimising of energy consumption via economy of energy as a result of optimisation as well as new technologies and sources of biofuels. Ill people benefit from optimised and individual medical therapies. European area benefits from utilisation of technologically advanced knowledge based economy. Ecological advances because of biologically sustainable strategies developed using SB approach.

Risk areas

1. Main expected risk is difficulties for specialists of one of the branches (experimentalists or modellers) to learn and understand the approach and technologies of the other branch. That may lead to opinion, that collaboration in SB among experimentalists and modellers is not effective and has no sense because of too different background and complexity of each branch.

2. Different terminology in particular branches is another challenging aspect of interdisciplinary innovation transfer.

3. Motivation to move into interdisciplinary field may be too low as both molecular biologists and information technologists are highly demanded on the market even without interdisciplinary skills.

Expected results

1. MOSBIO Website. Website will act as a communication tool between partners and representatives of target groups: Managers, technologists and research and development specialists, teachers that are involved or will be involved in the world of SB.

2. Definitions of Systems Biology educational modules. To find individual rational education path for monodiscipline (like biology, information technology, mathematics, physics, chemistry and others) specialists to enjoy SB one has to name its contents that are split in modules. These definitions will be used giving suggestions regarding sequence of necessary educational modules to reach necessary competence in SB taking into account start knowledge of particular specialist.

3. Systems Biology educational modules. The modules will be built up accordingly their definitions and will contain information and links to sources of correspondent sources of information. The modules will be available on CD end of 2009.

4. MOSBIO pilot courses. Pilot courses will be used to test our ideas how they work with real people. That will be efficient way to get feedback and improve our approach.

5. MOSBIO conference. The conference will be held at the end of 2009. The project materials will be presented as final version. Our experience in creating materials and organising courses will be summarised.

Navigation tool

One of the key features of MOSBIO project is the navigation software that gives suggestions to a particular user of the modular education system: which modules in particular sequence have to be studied to reach targeted knowledge within area of interdisciplinary SB starting with existing skills in a monodiscipline (see Figure. 1).

Input data of the navigation tool regarding person to be trained consists from 1) information about existing knowledge of person, 2) information about expected education result in terms ability to perform some SB related activities as part of interdisciplinary team and 3) belonging to a particular target group (managers, technologists, scientists or teachers).

Existing knowledge can be registered by filling in a starting knowledge questionnaire where subjects of different branches are listed and the student can express level of familiarity with each of them.

Expected education result can be expressed as theoretical or (and) practical skills in particular activity of SB (for instance, modelling, microarray analysis, metabolic engineering…). Expected result can be defined by choosing it from the list offered by navigation tool. Alternatively it can be defined as the easiest (nearest) alternative to be reached with given existing knowledge of the student.

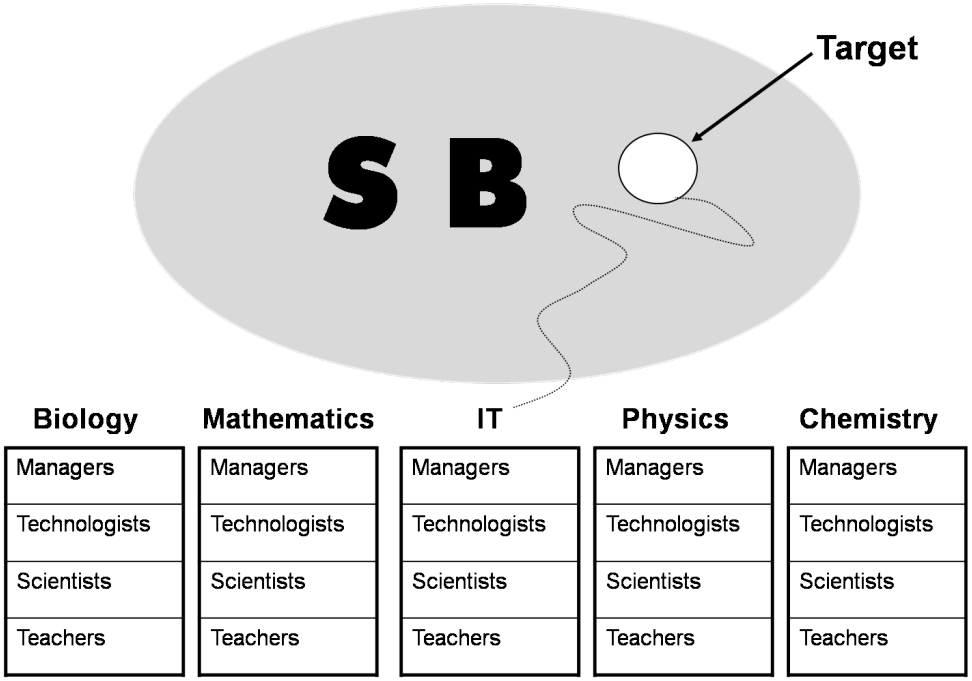

Figure 1. The task of navigation tool: taking into account educational background (biology, mathematics…), belonging to a particular target group (managers, technologists…) and the target of education a path consisting of educational modules sequence has to be suggested.

Conclusions

EU Life Long Learning program Transfer of Innovation project 'MOdular education for interdisciplinary Systems BIOlogy' (MOSBIO) has to contribute the delivery of scientific progress to the industry (Science->Education->Implementation) as well as distribute the expertise of most developed countries to the rest of EU.

The main idea of the project is to split SB competence in a number of educational modules to allow target oriented individualised vocational education of managers, technologists, scientists and teachers as the main groups of beneficiaries.Partnership consists of 6 partners from 5 countries (Latvia, Germany, Estonia, Finland and Spain) representing 3 universities, 2 SME and 1 professional association. Potential users are industrial and research organisations being able to increase their technological advance in knowledge based industrial branches due to technological knowledge.

Expected results of the project are: definitions of educational modules, contents of educational modules, MOSBIO website, pilot courses (to get the feedback about modules) and MOSBIO conference at the end of 2009. During the project a navigation tool will be developed to suggest sequence of modules that would help the beneficiary to choose a good way to get necessary knowledge without deep studies of the entire SB field.

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