Knowledge Integration Points in Contemporary Business Informatics

Renate Strazdina, Marite Kirikova, Peteris Rudzajs

Riga Technical University

The paper discusses different options of positioning Business Informatics in different cycles of the European educational system and corresponding methods of achieving the needed level of knowledge diversity required for cross-disciplinary programs. The role of standards and applicable ICT tools is discussed. Natural and artificial methods of knowledge integration are proposed, described and to some extent evaluated.

Keywords: Cross-disciplinary program, knowledge integration, Business informatics

Introduction

Cross-disciplinary programs have become one of the essential needs in the current scientific and educational situation. This need arises from the fact that the depth and breadth of knowledge has grown considerably, but differences in mental models and conceptual structures behind the disciplines hinder their easy integration in research and education. Business Informatics (hereinafter – BI) belongs to cross - disciplinary fields that try to integrate different information and communication technology (hereinafter - ICT) areas with different general as well as specific business fields and thus faces the abovementioned problem.

This paper considers knowledge integration in BI study programs and discusses how knowledge integration can be supported by means of ICT.

The discussion starts in Section 2 with a brief introduction to knowledge integration approaches that are useful in the context of study program development. In Section 3 we show the different options of knowledge integration approaches in several BI programs. In Section 4 we briefly discuss problems that arise in interdisciplinary study program development in general and BI in particular. In Section 5 we present an architecture of an information system that supports study program development and change management. In Section 6 we show different options of knowledge integration points in two educational cycles described previously in the paper and depict which of these points can be supported by the information sys-

tems architecture presented in Section 5. In Section 7 we present brief conclusions and further research directions.

2. Knowledge integration approaches in cross-disciplinary programs

There are many knowledge integration approaches developed that can be used for different purposes. In this research the following two knowledge integration approaches were analysed: (1) the move from 'knowing-how' to 'knowing-that' [1, 2]. Rolfe (1998) [3] constructed a typology of knowledge that incorporates scientific, experiential and personal domains and further characterized these into either theoretical (knowing-that) or practical knowledge (knowing-how); (2) the four ontology integration approaches: ontology mapping; ontology alignment; ontology transformation; ontology fusion [4]. Both of them were chosen as the former one is used by the authors for educational systems and the latter one could be appropriate for a cross-disciplinary program.

According to Stokols et.al [5] cross-disciplinary research has the following qualities: (1) multidisciplinary – researchers in different disciplines work independently or sequentially each from their own disciplinary – specific perspective, to address a common problem; (2) interdisciplinary – researchers work jointly but from each of their respective disciplinary perspective, to address a common program; (3) transdisciplinary – researchers work jointly to develop a shared conceptual framework and methodological approach that integrates and transcends their respective disciplinary perspectives to address a common problem. As the base for an educational program is science and research the same qualities are applied for a cross-disciplinary program. According to the characteristics of the cross-disciplinary program all of the four ontology integration approaches can be appropriate for different courses depending on the mix of the directions. The first knowledge integration approach can be appropriate for this research as BI is a course where the practical part of the course should be as important as the theoretical one.

3. Business informatics: an example of the cross-disciplinary program

In order to define the existing knowledge integration models applied for the cross-disciplinary program the existing Business informatics curriculums were analysed. As according to the Bologna declaration [6] the European educational system is based essentially on two cycles: a first cycle geared to the labour market and lasting at least three years (bachelor level), and a second cycle (master level) condi-

tional on the completion of the first cycle, these two cycles are in the scope of the research described in the paper.
The analysis was performed under the following structure: the proposed educational system cycle (bachelor/master); the previous program and the following program; the number of ICT related courses (mandatory/elective); the number of business related courses (mandatory/elective); the number of other courses (mandatory/elective).

All together 13 BI programs were analysed. There are 4 bachelor programs and 9 master programs of which 2 programs (20 %) are an extension of the bachelor programs at the same university. There is one bachelor program that is not followed by a master program and there are 7 master programs that are not related to the BI bachelor program.

The mix of the ICT related courses, business related courses and other courses differ from one case to another. A 50:30:20 mix is applicable in 7 cases while a 80:10:10 mix is applicable in 4 cases. There are 2 cases where 20:70:10 mix is applicable. The mix of theory and practice differs across different programs.

An analysis of the existing BI programs shows that all of the previously mentioned knowledge integration models are used in the BI programs.

The following conclusions can be derived from the analysis of the existing BI programs: (1) the most popular approach is to offer a cross-disciplinary program after the first cycle of the education system is finished, so the first basic education program is completed and the conditional cycle is used as an additional education, however there are some exceptions; (2) the most popular mix for the BI is 50:30:20 where ICT courses are included at bigger extent than other courses, however it should be taken into consideration that some of the ICT courses have some part of the business related courses integrated within them; (3) there are different knowledge models used in the BI programs. It leads to the conclusion that the means used for the support of the cross-disciplinarily programs should support a different mix of the courses and different knowledge integration models.

4. Cross-disciplinary program development

This section briefly discusses problems that arise in interdisciplinary study program development in general and BI in particular. The problems were defined during an expert discussion and were divided according to the SWOT analysis methodology into strengths and weaknesses and opportunities and threats. The experts are involved in the development of the BI program at Riga Technical University.

The analysis is based on the results of the previous research that shows that, in developing the study programs, it is important to take into consideration not only the applicable academic requirements but also industry needs [7,8], so both aspects are taken into consideration.

The following aspects were mentioned as the **strengths** of the cross-disciplinary program: The cross-disciplinary program utilizes high level balanced knowledge from several (usually two) disciplines instead of emphasis on one particular discipline and so promotes the utilization of knowledge of crossed disciplines. As a result these programs may provide unique knowledge which cannot be acquired by studying two basic disciplines in parallel or one after another. One more strength point is that these programs can be adapted to market needs in several ways (more IT part or business part). From the university point of view on the cross-disciplinary programs there is a broader scope of future students and research preformed in these programs can lead to brand new products.

By analysing the possible **weaknesses** the following aspects were named by the experts: The staff of basic programs is not prepared for cross-disciplinary programs in terms of experience, knowledge, teaching materials, teaching techniques. The staff of basic programs might not be interested in cross-disciplinary programs as it could lead to additional effort in preparing the courses because cross - disciplinary programs require broader knowledge in different areas in comparison to basic programs and not all staff members could be interested in acquiring such knowledge and the cross disciplinary programs require developing "bridge knowledge" in order to integrate the different disciplines. The additional possible weaknesses mentioned were the following: the acquired degrees may appear unknown for industry and as the result there will not be well known job positions for graduates.

As the **opportunities** the following aspects were defined: these programs may help a university to vary resource allocation among several study programs, which suggest more flexibility in staff development, there is a possibility to include in teaching staff PhD holders from industry with previous teaching experience and business organizations can be more interested in these programs either as sponsors of lectures or providers of internship places or providing information for the case studies.

By analysing the **threats** the following aspects were named by the experts: The branches of basic programs may overlap considerably with cross-disciplinary programs and in case the same staff works for basic and cross-disciplinary programs gradually all programs may converge to the same contents. The programs might be not recognized by the industry because of the unclear position in the knowledge sphere.

The analysis of strengths and weaknesses shows that there is a set of issues related to the utilization of the different knowledge models, however in the case of the cross-disciplinary program the difference is not only between the industry and the university's one particular study program but also among the university's different study programs and at least two different industries. And it goes even further as the weaknesses analysis shows "Cross disciplinary programs requires developing "bridge knowledge" in order to integrate different disciplines". So there is a place where the ICT tool can support the lectures of the cross-disciplinary programs.

The analysis of opportunities and threats shows that the extent of the issues that could be supported or solved by ICT means is not as big as for the issues that could be solved by lecturers, however there is a set of issues related to the utilization of the different knowledge models, so the appropriate ICT tool can be adapted and in case of the cross-disciplinary programs can support the raised issues. The next section describes the architecture of the ICT tool proposed by the authors of the research.

5. Knowledge integration system

As it was concluded before, the issues related to the cross-disciplinary programs development can be solved either by mental means or by ICT tools. This section describes the proposed ICT tool, namely the knowledge integration system (hereinafter – KIS) [9]. According to the previously described analysis the KIS need to address the following main problems associated with the analysis of the overlap between the different study courses from different academic areas and the different needs from different industries, and analysis of the intersection points of different study courses.

The KIS model is based on an ecosystem approach and a study program-orientated multilevel information fusion approach [8]. Information fusion is the process of utilizing one or more data sources over time to assemble a representation of aspects of interest in an environment [10]. This approach helps to deal with the problem of how to establish the particular knowledge model that can be shared by all the ecosystem's members [11]. In this research the university, study courses, students and industry are ecosystem's members that make the ecosystem. While for different ecosystem elements there are different ways of representing knowledge, communication of its contents is usually done by using some knowledge mapping technique [12], i.e. a kind of map is developed as an abstract indicator of knowledge contents. However, in different study courses various mapping techniques (if any) can be used, e.g., knowledge taxonomies, ontologies, etc. [13], [14] therefore one of the problems is the establishment of a particular knowledge model that can be shared by all of them. [10]. The previously mentioned problems are solved by using the proposed KIS.

The architecture of an intended KIS provides multiple ways of information gathering, fusion and representation. The KIS architecture is presented in Figure 1. Originally the architecture is developed for basic programs instead of the cross-disciplinary programs, however with minor amendments the same architecture can be used for the cross-disciplinary programs.

The architecture of this solution consists of two layers. The first – service - layer consists of a number of information acquisition and analysis services. The second layer consists of representation services.

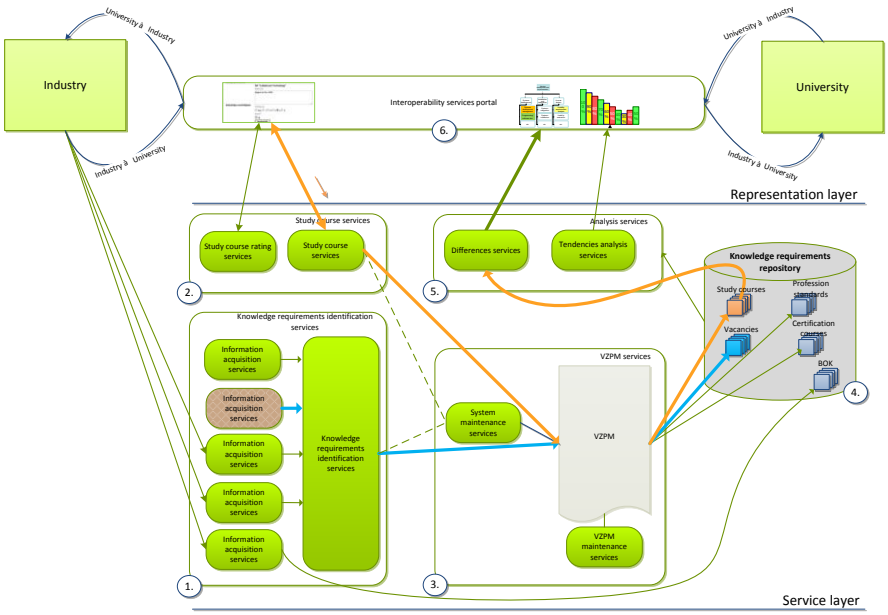

Figure 1 KIS architecture

So far the KIS architecture is mainly developed in order to support knowledge acquisition from the industry and regulatory organizations regarding the necessary knowledge (know-what) and skills (know-how) that should be included in the study courses. It is done by using the Knowledge requirements identification services (1). The acquired knowledge are transformed via VZPM services (3) and stored in the Knowledge requirements repository (4).

So far the architecture contains two analytical services (5) that use the stored information: Differences services and Trends analysis services. These services allow identifying the changes needed in the existing study courses (2). The results of the analysis are represented by using the Interoperability services portal (6).

As the architecture is in the process of development the completed parts are planned for basic programs and are mostly orientated towards knowledge acquisition from the industry and comparing them to the existing study courses. In order to support fully the study course development process the services for knowledge acquisition from the research should be developed further. In the next session we illustrate how this architecture could be applied in the case of Business Informatics.

6. Knowledge integration points in cross-disciplinary educational systems

In order to use the proposed KIS architecture for cross-disciplinary programs in general and BI programs in particular minor amendments should be implemented.

The amendments are required in the service layer, where more services should be developed in order to obtain the knowledge requirements from the more than one industry. The other part of the knowledge acquisition services that should be amended is related to study courses from different areas. That means that special transformation services that can work with different ontologies should be implemented in the VZPN services (3).

In case of the BI program KIS should be able to work with ontologies used in the ICT industry and more general business and at the same time with ontologies used in ICT study courses and Management study courses.

Conclusions

Knowledge integration can be organized in different ways both naturally and artificially. The paper analyses knowledge integration issues related to the cross-disciplinary study programs and in particular these that can be solved by using appropriate ICT tools. One of the possibilities is to use the KIS architecture described in Section 5, however in order to use the KIS for cross-disciplinary programs amendments that support knowledge integration and integration relation maintenance from different industries should be implemented in the proposed architecture.

References

1. Schon, D.A. (1983). The Reflective Practitioner: How Professionals Think in Action. London: Ashgate.
2. Rolfe, G. (1998). Education for the advanced practitioner. In: RolfeG, Fulbrook P (eds), Advanced Nursing Practice. Oxford:Butterworth-Heinemann.
3. Polkinghorne, D.E. (2004). Practice and the Human Sciences: The Case for A Judgement-based Practice of Care. New York: Suny.
4. Kalfoglou, Y., Schorlemmer, M. (2003). Ontology mapping: The state of the art. The knowledge Engineering Review, 18 (1). 1-31.
5. Stokols, D., Taylor, B., Hall, K., Moser, R.: The science of team science: An overview of the field //available at http://dccps.cancer.gov/BRP/scienceteam/Team_Science_Overview_Stokols_etal.pdf . Accessed 24 Apr 2010.

6. The Bologna declaration: an explanation//available at http://ec.europa.eu/education/policies/educ/bologna/bologna.pdf Accessed 24 Apr 2010.
7. Kirikova, M., Strazdina, R., Sukovskis, U.,(2008) Supporting Inter-Institutional Knowledge Feedbacks in the Context of Engineers' Educational System // Proceedings of International Conference of Education, Research and Innovation ICERI2008, Spain, Madride, 17.-19. November, - pp 560-570.
8. Kirikova, M., Strazdina, R., Andersone, I., Sukovskis, U.(2009) Quality of Study Programs: an Ecosystems Perspective // Workshop on Intelligent Educational Systems and Technology-enchanced Learning (INTEL-EDU) associated to the 13th East-European Conference, ADBIS 2009, 13th East-European Conference on Advances in Databases and Information Systems . – pp. 300-310.
9. Rudzajs P. and Kirikova M. (2009) IT knowledge requirements identification in organizational networks: cooperation between industrial organizations and universities. The 18th International Conference on Information Systems Development (ISD2009), September 2009. – Nanchang, China
10. Bosse, E., Roy, J., Wark, S. (2007) Concepts, Models, and Tools for Information Fusion. Artech House
11. Chang, V., Guelt, C.(2007) E-Learning Ecosystem (ELES) – A Holistic Approach for the Development of more Effective Learning Environment for Small-and-Medium Sized Enterprises (SMEs). In: Inaugural IEEE International Conference on Digital Ecosystems and Technologies, pp. 420-425. IEEE Press
12. Okada, A., Shum, S.B., Sherborne, T.(2008) Knowledge Cartography: Software Tools and Mapping Techniques. Springer
13. Subrahmanyam, G.:(2009) A Dynamic Framework for Software Engineering Education Curriculum to Reduce the Gap between the Software Organizations and Software Educational Institutions. In: Proceedings of the 2009 22nd Conference on Software Engineering Education and Training, pp. 248-254. Washington
14. Guide to the Software Engineering Body of Knowledge, Institute of Electrical and Electronics Engineers (2004)