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The Challenges of Implementing Software Industry in University Academic Environments

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ABSTRACT: Highlighting the importance of establishing linkages with the industry and university environment, this paper presents the need to redesign university curriculum responding to the emphasis to develop productive workforce that can contribute to the economic progression and wellbeing of the society. In this paper, the challenges of establishing software industry in university academic environments are presented. Understanding these challenges are considered necessary as they play significant role in shaping the design of a curriculum for university vocational training. Further, the challenges are considered as threats that can be identified in the university environment; hence, they must be addressed, resolved and understood as opportunity. This research adopted a mixed approach methodology and a discursive-hermeneutical analysis of the emergent and hegemonic aspects described by the literature to identify variables and units of analysis. Additionally, a correlation analysis of categories was conducted based on a survey data collected from 53 students of Systems Engineering at a particular university in Latin America. Comparisons between learning chains in university and production chains in software industry were also conducted. The results show that there was a strong relationship between the industry, academic environments and strategic knowledge. Finally, conclusions and future lines of work are considered.

KEYWORDS: Software Industry, Education, Systems Engineering, University Vocational Training.

1. INTRODUCTION

The accelerated development of technology and the exponential generation of data and information propose an interesting space for debate and analysis of the social, cultural and academic responsibility of the Systems Engineering programs with its graduates and organizations in the region. To ensure graduates employability, it has become a necessity for universities to equip their students with the necessary skills and environment similar to the workplace. In relation to this, universities, especially the technical universities worldwide have made a priority to establish a strong linkage between the productive sector and the academia. Considering the rapid and widespread development of software industry, these universities are making the move to integrate the requirements of software industry in their software engineering curriculum as a strategy to link the academic world with the world of life. In this case, there is a need to redesign the software engineering curriculum that meets the dynamic demand of the software industry.

Re-designing a curriculum needs careful planning and actions as it has direct implications to the students experiencing the learning environment shaped by the curriculum design. An effective curriculum should demonstrate a real coherence between what is taught, what is learned and what is intended to develop. Further, Bigg's model of constructive alignment in curriculum design emphasizes the need for coherence between assessment, teaching strategies and intended learning outcomes [1]. Therefore, considering this information play significant role in shaping the design of a particular curriculum, it is necessary for educators to understand and consider variety of approaches, challenges, opportunities and threats generated from the academic environment.

This paper presents an analysis on the challenges of implementing software industry in institutions of higher education particularly in the context of Latin America. Findings from a survey was drawn to determine the elements involved in the process of linking the two environments, namely the industry, the academic from the perspectives of teaching and the students will be presented as well. It should be noted that a good approximation to an implementation of the software industry in academic

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environments is related to the balance between the expectations of the entities associated with these processes. This balance must be sought among students, teachers, industry and society. Although it is imperative to solve the needs of the industry, the aspirations and preconceptions of the other members of the educational process must also be considered due to the emergent trends that are likely to arise and the course of technological development in the years to come.

2. CHALLENGES OF IMPLEMENTING THE SOFTWARE INDUSTRY AT THE UNIVERSITY

This section presents the challenges of integrating the requirements of software industry in universities, which were drawn from the existing literature. For this purpose, five main challenges have been identified and they are described below.

2.1 Determining the Level of Consistency between the Needs of Products and Sectors of Software Industry and the Curriculum in Software Engineering at the University

According to the 2010 Economic Commission for Latin America and the Carribbean (CEPAL)[2], "the development of the countries of Latin America and the Caribbean will increasingly depend on their ability to generate the knowledge and skills necessary to foster economic and social innovation, as well as to increase its effects on economic growth, social inclusion and environmental sustainability". This statement indicates the necessity to redefine the relationship between the market, state and society that has prevailed for three decades and that has failed to respond to the challenges of development and close the productive and social gaps. In this case, there is a need to strengthen the rolesof universities as the training institution for professionals.

2.2 Incorporating Sustainable Development of Science, Technology and Innovation into Emerging Geographic and Policy Environments

Software Development belongs to a sub-nucleus of a much broader structure, such as the Information and Communication Technologies, which, in the last decades has produced new paradigms directly related to the social and economic development environments. At a global level, the imperative of innovation in different fields has been translated into an abundance of new applications of technology in the productive and competitive economic sectors, with undefeatable condition of sustainability and fundamental purpose for the societal wellbeing. In this development, there has been an exponential generation of new data, information and knowledge.

2.3 Software Development in the Generation of the New Dimension of Renewal for the Incorporation of New Paradigms of Development of Science, Technology and Innovation

According to the above and in the effort to enforce it permanently, it is necessary to develop strategies and actions that are the case, in order to close the gap, or at least have the expectation to keep it from spreading. In addition, to enable it to happen, a new dimension of renewal should be generated, giving a more coherent support to the development of the information society, the knowledge society and the network societyto give rise to a true intelligent society in all its dimensions[3]. This initiative will trigger new strategies for social and economic development, with greater levels of equality, equity and inclusion. This results in the greatest benefit to social, collective and community organization in each of these geographical and political orders that are suffering from them.

2.4 The University Immersion Process in the Context of Productive and Economic Development

In this context, it is very clear that there is an urgent need for a university to immerse in the real world, which is characterized by the above conditions. This action results in the continuity of the development of curricular proposals for training in software engineering. The training in this area is aligned or at least parallel to the new needs in this area that are continuously emerged from the social, economic and all spheres. Additionally, it is imperative to realize other benefits resulting from this immersion, such as the opportunity to experience other learning scenarios that are different from the traditional classrooms so that they can carry out the practices of the new professionals. In connection with the reality and beyond the study cloisters that are often far removed from the business environment, politics and all those imperatives that new globalized orders entail. The training should also lead to learning and competence development for the new professionals and derived from the processes of Research and Innovation in the development of software. Other benefits derived from the training are the the direct link with the contexts in which the real dimensions of labor, occupational and even of entrepreneurship, that tends to be self-employed.

2.5 Productivity and Innovation, for the Improvement of the Quality of Life, in Conditions of Equality, Equity and Inclusion of the Society in General, in the Curricular Agenda of the University Professional Training in Software Development

As mentioned earlier, universities are facing great challenges as they have find ways to provide a bridging between the university environment and industry

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particularly in the area of software development. In particular, universities have to ensure make an alignment between the content of the curricula of teaching programs for professionals of the development of software with the need of the software industry. Guidelines and new paradigms of social and economic development are essential to ensure effective and successful achievements of the true social and economic transformations. It is common practice for an increased productivity, production in the industry and manufacturing can be perfected through innovation in value-added services, while innovating in the processes of horizontality of the business schemes that make possible new models of value chain, adjusted to the new reality of the internationalization. This is based on the development of new software applications that supports these new paradigms throughout the productive pyramid from the operational, functional areas and processes, tactics, strategies, prospects and business intelligence [4]. Making clear the fact that if there is coherence between vocational training and the contexts of the social and economic reality of the different political and geographical orders, productivity will be the result of innovation, for the improvement of the quality of life within the context of equality, equity and inclusion.

3. RESEARCH METHODS

The research was conducted in particular university in Latin America. The university of the case study has adopted a strategy called Integrator Projects via Project Based Learning that requires students to work on an industry related project, which is normally experienced by a real worker in the industry. In this project, an expert assessor also called as the “learning chain” is created, depending on the project topic.

Contextualized within the aforementioned panorama, a case study has been conducted to determine the elements involved in the process of bridging the two environments, namely the industry and the academic from the perspectives of teaching and students. For this purpose, a survey was conducted with 53 first year students at a university in Medellin, Colombia. Framed with a previous experience of implementation in a software engineering program, the survey focused on analyzing factors or elements that influence the integration of software industry within an academic environment.

A dependence analysis of the variables was proposed using a χ^2 test [4] with a sampling error of 5% with 95% confidence, assuming a 15% of sample heterogeneity. The population selection was done based on structural sampling [4]. The formula used to calculate the sample size was:

$$n = \frac{N \cdot Z^2 \cdot p \cdot q}{d^2 \cdot (N-1) + Z^2 \cdot p \cdot q} \qquad (1)$$

Further, this study tested the following null hypothesis and alternative hypothesis:

i. *h_0=The variables "strategic knowledge" and "knowledge of the difference between the software laboratory and software industry" are independent.*

ii. *h_1= The variables "strategic knowledge" and "knowledge of the differencebetween software laboratory and software industry" are dependent.*

The variable "strategic knowledge" was dichotomous with yes and no values, while the variable "knowledge of the difference between software laboratory and software industry" weremeasured based on a scale of 1 to 5, in which 1 as the lower knowledge and 5 as the greater knowledge.

This research used a mixed approach methodology and a discursive-hermeneutical analysis of the emergent and hegemonic aspects described by the literature to identify variables and units of analysis. Additionally, it was necessary to usea non-parametric fit test between the learning chains in university and production chains in software industry to identify the link between this two concepts.

4. RESULTS AND DISCUSSION

Data derived to test the two hypotheses are presented in Table 1 and Table 2 below. To test the null hypothesis, 4 degrees of freedom were adopted, and we had a value of $\chi^2 \approx 9{,}54$.Based on the value, it is possible to reject the null hypothesis and approve h_1. It can be concluded that the variables "strategic knowledge" and "knowledge of the difference between software laboratory and software industry" are dependent.

Table 1. Data obtained from the first question

Scales	1	2	3	4	5	Total
YES	0	2	6	8	9	25
NO	7	4	5	8	4	28
Total	8	8	14	20	18	53

Table 2. Values for Chi-Square

0,83358491	0,73056604	0,27231561	3,32083857	0,87331536
0,74427224	0,65229111	0,24313894	2,96503444	0,77974586

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We also tested the following null and alternative hypothesis:

i. *h_0=The variables "strategic knowledge" and "knowledge of the dynamics of software development in the industrial sector" are independent.*
ii. *h_1= The variables "strategic knowledge" and "knowledge of the dynamics of software development in the industrial sector" are dependent.*

In this case, the variable "strategic knowledge" was dichotomous with yes and no values, while the variable "knowledge of the dynamics of software development in the industrial sector" were assumed based on a scale of 1 to 5, in which 1 was considered as lower knowledge and 5 as the greater knowledge.Data derived to test the two hypotheses are presented in Table 3 and 4. The results drawn from 4 degrees of freedom Value is $\chi^2 \approx 11{,}41$. Based on the results, we rejected the null hypothesis (h_0) and approved the alternative hypothesis (h_1). It can be concluded that the variables "strategic knowledge" and "knowledge of the dynamics of software development in the industrial sector" are dependent.

Table 3. Data obtained from the second question

Scales	1	2	3	4	5	Total
YES	2	6	4	8	5	25
DO NOT	6	12	7	1	2	28
Total	8	18	11	9	7	53

Table 4. Values obtained from Chi-Square

3,30188679	0,24352201	0,12686106	0,02716981	1,34130624
2,94811321	0,21743037	0,11326881	0,02425876	1,19759486

Table 5. Relation between academic projects in learning chains and industry chains in software development

	Design and Implementation of Information Systems using quality and testing	Development/ software Factory	Solutions Integration
Learning chain (65 projects)	24,00	34,00	7,00
Expected in software industry	32,435	25,22	7,215

Based on Table 5, it is possible to obtain a chi-square value or $\chi^2 = 5.25 < 7.815$, which shows an adequate adjustment between projects for learning chains and projects for software industry chains.

Based on the results, it can be analyzed that an strategic knowledge is fundamental to initiate a process of software industry in academic environments, since it allows students to generate the capacity to make decisions in complex environments and attendto the principles of externalization of the knowledge of the teacher (In this case the expert). It is vitally important to generate a virtuous circle of project training that allows a continuous relationship between the various fields of knowledge related to the conformation of software development knowledge, taking into account the difficult task of transforming tacit knowledge into explicit knowledge [7].Figure 1 summarizes the process of developing the strategic knowledge that bridges the software industry and academic environments. As shown in Figure 1, there are four elements that are interrelated with each other for the development of strategic knowledge [8]. These elements are i) correlation between students and researchers, ii) the correlation between the teachers (experts) and students, iii) the correlation between the software industry (productive actors) and research, and iv)the correlation between the industry and students [9]. It is important to note that these factors are intertwined and interrelated to each other towards the development of the strategic knowledge of the students. Further, students who have gained the strategic knowledge are considered as well-equipped with the necessary skills and knowledge to contribute productively to the prosperity of the economy and well-being of the nation [10].

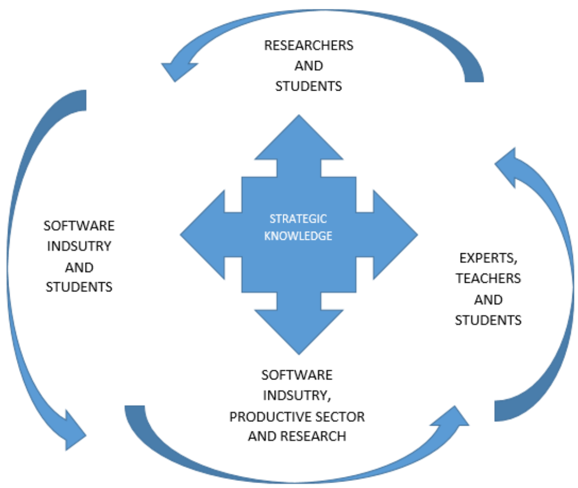

Figure 1. Relational diagram of the software industry in the university case study

5. CONCLUSION

It is widely known that the determinants of the new order of social development are fundamentally characterized by a change in a systematic way. They also contribute to the development of productive and competitive organizational sectors. In this sense, this characterization of the changing society, which is evidenced in its plurality and heterogeneity, gives rise to the fact that the processes of formation itself have a quality of flexibility and understanding, on the part of the one who imparts the knowledge. This is based on the assumption that there is a new role of facilitator. Facilitator of changes and transformations are required for a real process of professional training that is

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integral to the being, knowledge, doing and even being of that new professional. It will return to society in a role of innovative agent, to exercise the leadership that corresponds in the processes of reconversion as agent of change in different social and productive environments, in which it is necessary to develop in the labor, occupational, professional, family, social and individual.

It is unquestionable to say the least that the leading and transcendental role of the present education and vocational training today requires a permanent approach in the distant future. These requirements must be assumed with a forward-looking nature of the professional formation. To create this forward-looking nature on the part of the faculty, the knowledge, competences and abilities of the new professionals need to be developed with celerity, capacity of adaptation, to accept, to promote and to make the permanent change, that allows them to be positioned as active members, of high excellence and successfully within the intelligent and networked society, in which they have been granted the privilege of living and performed as professionals.

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