A MULTIDISCIPLINARY EDUCATION FRAMEWORK THAT EXPLOITS IT UNDERGRADUATES TO ELIMINATING LACK OF IT SKILLS IN NON-IT GRADUATE DISCIPLINES

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ABSTRACT
Due to the lack of necessary Computing and Information Technology (IT) skills, education in many disciplines, such as, Communication and Media Studies, Education and Economy were said, not to have produced the results demanded by the related industries. Here, we suggest an effective and economically feasible educational framework where the graduates from the Information Technology departments, fully proficient in data collection, processing and management besides system analysis skills, would continue their graduate/postgraduate education in such disciplines without wasting any time in completing the deficiency programs through the use of free-elective courses which are already available in their curricula.

1. INTRODUCTION

As the Information Age is entered, every sector of the world economy needs to employ IT specialists or IT literate people, resulting in a growth in IT related occupations [1]. This will yield an increasing demand for either IT professionals or IT literate subject specialists, who will be referred to as professionals in this work. Employing IT specialists in areas where professional skills are required, will hinder overall company performance due to insufficient level of subject-specific skills of the IT specialists [2,3]. IT professionals that aim to get promoted in their companies need to develop communication, business processes, strategic planning and technological skills. Otherwise, they will not be favorite candidates to be promoted to management positions. Hence, to adapt to the fast pace of digital transformation, a need to subject specialists with high level of IT competency arises. Since the current curricula and educational systems do not aim such a set of skills in their graduates, a new multidisciplinary education framework to graduate students with sufficient level of IT specialization and professional skills as well as the necessary skills must be designed.

In the article by Callahan and Pedigo [4], a multidisciplinary education model mixing the Information Engineering and Management disciplines has been introduced in order to fill the gap created by the shortage of executive level technical talents in the industry. In the article, the entire process from defining the objectives of an educational program to developing courses and managing a special group of executive students is covered in a horizontal educational model where both Information Engineering and Management education is offered simultaneously.

A transdisciplinary master of engineering program is developed [5] in order to establish a closer relationship between industry and educational institutions. They define transdisciplinary education and research as a logical extension of interdisciplinary and multidisciplinary programs. The authors analyze the cases of managerial weakness of employees trained in engineering and technical weaknesses of employees trained in business. The method presented here also minimizes the interaction with other disciplines through the disciplinary territories since the students enrolled in the undergraduate program should graduate before they can engage in this program.

The article by Maskell and Grabau [6] deals with a Multidisciplinary Cooperative Problem-Based Approach to Embedded System Design. The course is taught with a problem-based learning scenario, to the second year undergraduate students coming from different degree programs. Since multiple disciplines are presented to the students at the same time, the method introduced in this article is said to be horizontal as well.

In the article International Virtual Design Studio [7], the authors present the studio originated between the Mechanical and Electrical and Electronic Engineering Departments of three different universities. The success of this project is said to be highly dependent on well-defined project specifications, a single source of project information, incentive for students to participate, travel to participating countries, a balanced team structure and

participation by all students. The article by Doom at al [8], a baccalaureate computer science option is introduced to Bioinformatics, which is multidisciplinary itself by nature.

Báez-López and Montero-Hernández presents [9] an interdisciplinary electrical and computer engineering curricula, which allows students to get a knowledge of the different disciplines within engineering practice, such as mechanical, systems, civil, industrial, chemical and food engineering. Metaxas and Ribner [10] wrote their experiences about an interdisciplinary course where art and computer science students worked in assigned pairs to produce an interactive multimedia project.

In this article, a vertical educational model for multidisciplinary education is presented, in which, the IT related skills are given first and the professional skills are then gained with the aid of the already possessed IT skills. The method we propose is expected to work more successfully since the education activities themselves are augmented by the existence of the IT skills. The time and stage of transition from IT education to professional education can be adjusted depending on the geographic and target market needs.

This paper is organized as follows: Section 2 describes the skills required for a successful carrier in an industrialized society. Section 3 briefs the background requirements for multidisciplinary education. Multidisciplinary education framework generic issues are discussed in section 4 and section 5 studies some specific cases. Section 6 summarizes and concludes the article.

2. THE SET OF SKILLS REQUIRED FOR A SUCCESSFUL CARRIER IN AN INDUSTRIALIZED SOCIETY

In [5], a *discipline* is defined as a particular area of study provided that it has unified tools, techniques and methods and a well developed jargon. Disciplines are said to develop into self contained hard-shells, which tend to minimize interaction with outside entities and other disciplines through the fiercely defended territories.

Unlike many other disciplines, however, IT can not be abstracted from other non-IT professional disciplines. The main theme of the 1977 congress of Turkish Informatics Society in Ankara was; whether the people working in non-IT disciplines should learn programming or whether IT professionals will learn the non-IT professional skills such as accounting, inventory systems, medical sciences, etc. After a quarter of a century, the same subject is still being discussed in educational premises and we have seen that both may happen. Also at those times, there was also a fear that computers would replace skilled people. Still there is a need of experienced human force to use or program computers in various disciplines. So, the fear that, IT departments will get the control of other disciplines didn't come true.

The set of skills required for a successful IT profession could be exploited in three different categories the soft skills, the IT related skills and professional skills. Each of these skills will be investigated in detail in the following sections.

2.1. The Soft Skills

These are the general skills required of every person employed in an IT-aware workplace. The soft skills include, but not limited to, reading, writing (using a word-processor), language, mathematics, presentation, team-work, communication skills [5].

2.2. The IT Specific Skills

The IT related skills can be listed as, hardware and software aspects of information systems design, design and development of packaged software, use the soft skills and background IT knowledge in a problem solving capacity. IT related skills also include systems analysis, data collection and processing, data storage, computer system and network security, graphical user interface and application program development, and designing new solutions using computers. IT specialists can also take on duties as Database developer and manager, information system developer and operator, interactive digital media specialists, network specialist and technical support representatives for information systems.

2.3. The Professional Skills

These are the skills directly related to the major interest of the profession such as Economy, Accounting, Inventory Systems, Medical Sciences, Law Practice, Educational Sciences, Architecture, Business and Administration, International Relations, Engineering etc.

3. BACKGROUND REQUIREMENTS FOR MULTIDISCIPLINARY EDUCATION

In this information age a lot of people can be found which are graduates of non-IT but interested and educated themselves in IT. Besides, frequently there are people who are graduates of IT or computer engineering departments but specialized in another discipline in order to work in that business area. Since there is a great role of IT in every discipline, being a soft skill, computer literacy must be considered as a necessary element of the undergraduate education.

Most of the non-IT disciplines in current educational institutions have several IT courses at an introductory level in order to create an awareness of data collection, processing, storage and security issues. This can be recognized from the first year curriculum of various disciplines where there is at least one IT-related course. All of the departments in Eastern Mediterranean University (EMU) are giving an introductory IT education in order to make their students computer literate in their disciplines. As non-IT students from a variety of disciplines prepare to be the *information workers* of tomorrow, they must be able to use a variety of rapidly changing computer systems and tools to solve an ever expanding range of problems across disciplines [11]. However, these introductory level courses do not satisfy the IT skills requirement in departments such as Communication and Media Studies, Banking and Finance, Economy, Educational Sciences etc. specially, at M.Sc. or M.A. level, the lack of specific IT skills turn into a major handicap. Hence, the students enrolled in the Master programs of such departments should come from an IT background. But then, they will waste about a year before they complete the deficiency programs.

As a case study, the Department of Information Technology (DIT) in the Eastern Mediterranean University (EMU) is considered as the seed for our vertical multidisciplinary education framework. Students graduated from DIT are fully prepared to enter the M.Sc. or M.A. programs in any one of the 5 departments (they will be referred as target departments from here on) for further studies.

Table 1 shows the curriculum of DIT with reference to the courses acceptable for completing the deficiency programs in the target departments. Are these courses satisfying the needs of the students to get the required knowledge for those target disciplines? In the curriculum, DIT also have two non-major (NTE - non-technical elective) courses in 4th year fall and spring semester. Until now, most of the students selected language and arts and sciences courses as NTE. But those who are willing to learn more in depth subjects required in business were not willing to select any one of these courses. So, by multidisciplinary DIT curriculum, the students will have the chance of deciding their future carrier for graduate studies and select the courses related to that discipline.

Table 2 shows the Business and Management Courses while Table 3 shows the Mathematics courses in the DIT.

Table 1: The Curriculum of the Department of Information Technology

Curriculum of the Department of Information Technology					
FIRST YEAR					
Fall Semester					
EFL107/117/127	35211	English I	(3,0)3		
CSIT101	35212	Introduction to Computers & Info. Tech.	(2,2)3		
CSIT161	35213	Introduction to Business	(3,0)3		
CSIT113	35214	Algorithms & Programming Tech	(2,3)3		
MATH111	35215	Basic Mathematics I	(3,1)3		
TURK100*	35216	Introduction to Turkish	(2,0)0	S/U	
Spring Semester					
EFL 108/118/128	35221	English II	(3,0)3		EFL 107
MATH112	35222	Basic Mathematics II	(3,1)3		MATH111
CSIT114	35223	Structured Programming	(2,3)3		CSIT113
MATH161	35224	Mathematical Logic Comp	(3,1)3		
CSIT162	35225	Basic Economics	(3,0)3		CSIT 161

SECOND YEAR					
Fall Semester					
EFL 207/217/227	35231	English III	(3,0)3		EFL 108
CSIT225	35232	Internet Programming	(2,3)3		
CSIT213	35233	Data Structures and Applications	(2,3)3		CSIT114
CSIT255	35234	Computer Organization & Architecture	(3,1)3		MATH161

MATH211	35235	Introduction to Statistics	(3,1)3		
Spring Semester					
CSIT202	35241	Operating Systems	(2,3)3		CSIT255
CSIT212	35242	Database Management Systems	(2,3)3		
CSIT226	35243	Internet Applications	(2,3)3		CSIT225
CSIT234	35244	Systems Analysis	(2,3)3		
CSIT242	35245	Object Oriented Programming	(2,3)3		CSIT213

THIRD YEAR					
Fall Semester					
CSIT309	35251	Computer Networks	(2,3)3		CSIT202
CSIT313	35252	Database Programming	(2,3)3		CSIT212 ,
CSIT335	35253	Systems Design	(2.3)3		CSIT234
CSIT341	35254	Object Oriented Application Dev.	(2,3)3		CSIT242
TE	35255	Technical Elective	(3,1)3		
Spring Semester					
CSIT312	35261	System Programming	(2,3)3		CSIT202,
CSIT346	35262	Software Engineering	(2,3)3		CSIT335
CSIT354	35263	Programming Languages	(2,3)3		CSIT341
CSIT362	35264	Organisational Behaviour	(3,0)3		CSIT161
TE	35265	Technical Elective	(3,1)3		
CSIT300	35266	Summer Training	(s,u)0	S/U	

FOURTH YEAR					
Fall Semester					
CSIT421	35271	Management Information Systems	(3,1)3		
TE	35272	Technical Elective	(2,3)3		
TE	35273	Technical Elective	(3,1)3		
TE	35274	Technical Elective	(3,1)3		
NTE	35275	Non-Technical Elective	(3,1)3		
HIST200*	35276	History of Turkish Reforms	(2,0)0	S/U	
CSIT401	35277	Graduation Project Orientation	(s,u)0	S/U	
Spring Semester					
TE	35281	Technical Elective	(3,1)3		
TE	35282	Technical Elective	(3,1)3		
TE	35283	Technical Elective	(3,1)3		
NTE	35284	Non-Technical Elective	(3,1)3		
CSIT402	35285	Graduation Project	(3,0)3		CSIT401

Table 2: The Business and Management Courses in DIT

CSIT 161	Introduction To Business
CSIT 162	Basic Economics
CSIT 362	Organizational Behavior
CSIT 421	Management Information System
CSIT 445	Accounting Information System (technical elective)

Table 3: The Mathematics courses in DIT

MATH 111	Basic Mathematics I
MATH 112	Basic Mathematics II
MATH 161	Mathematical Logic for Computing
MATH 211	Introduction to Statistics

In the 21st century, students with different ethnic background, language skills, goals, and motivations are gathered in the same classrooms [12]. EMU being a multinational education environment, DIT has a high proportion of international students which are keen on continuing their education towards M.Sc. or M.A. in different disciplines to be more competitive in their future carrier. Since they have different goals in their future studies or life, they have interests in different subjects as business, tourism, accounting, education, etc. During

undergraduate, giving the required deficiency courses that are must for masters in the target discipline is considered to facilitate their acceptance. This will be done by giving these courses as free-electives. The target departments giving education for those disciplines also have positive approach.

4. THE MULTIDISCIPLINARY EDUCATION FRAMEWORK

By playing with the boundaries, the multidisciplinary education framework can be established in numerous ways, depending on the educational objectives and learning outcomes. Figure 1 which is the vertical model, currently employed in many well known universities, suggest that the students graduate from one discipline before they are enrolled in another. This model, which is shown in Figure 1.a conforms to the definition of self-contained, hard-shells, disciplines in [5], which tend to minimize interaction with outside entities and other disciplines through the fiercely defended territories.

The horizontal model employed in many disciplines such as [4,6,7,8] is shown in Figure 1.b.
In Figure 2, various types of vertical multidisciplinary education models where percentages of IT+Soft Skills and professional skills are controlled depending on the objectives and the learning outcomes.

The problems encountered in the vertical and horizontal model cases mentioned above could be solved by constructing an overlapping disciplines vertical model, where the final year (or final two years) curriculum of the undergraduate program is modified to include the courses in the deficiency programs of the M.Sc. or M.A. programs the students are aiming. The diagram in Figure 1.c shows the details of this model.

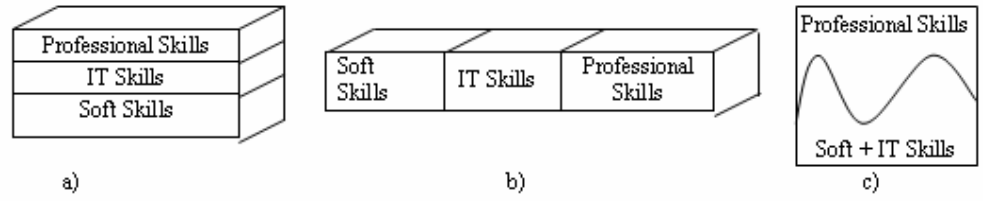

Figure 1. Several ways of establishing a multidisciplinary education framework,
a) the vertical multidisciplinary education model with fiercely defended boundaries
b) the horizontal multidisciplinary education model with fiercely defended boundaries
c) the vertical overlapping disciplines model of multidisciplinary education with fuzzy boundaries

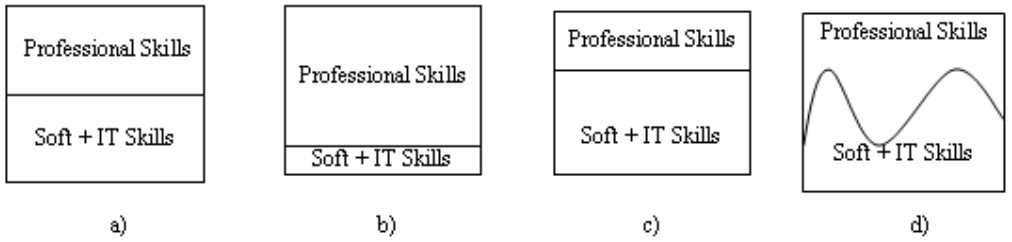

Figure 2. Various types of vertical multidisciplinary education models where the percentages of IT+soft skills and professional skills are controlled depending on the objectives and the learning outcomes.
a) 50 percent IT+Soft Skills and 50 percent professional skills
b) <<50 percent of IT+Soft Skills, >>50 percent professional skills
c) >>50 percent of IT+Soft Skills, <<50 percent professional skills
d) Mixed percentage IT+Soft Skills and professional skills.

Non-IT discipline courses will be taught by the instructors of those departments from the perspective of IT. These provide a foundation for continued learning [13], providing an understanding of how IT can be used in complex domain – specific problem solving in various disciplines. Case-study must be developed in order to implement their IT knowledge to those disciplines. Students see how professionals from different disciplines use IT to solve problems. Also students will learn to use tools in the practical laboratory hours, for solving problems in various disciplines (accounting programs, web-based instructional design programs, etc.) . Some topics that are taught in DIT courses like systems analysis and design, project management and software engineering are project planning, project scheduling, team management, organizational management, communications, risk analysis, and quality management. These topics cover the cases that also exist in different disciplines like business management, hotel management, and MIS. Also when term and graduation projects are given; they are concerned with real life business problems. The students have difficulty understanding the business problems.

These vertical multidisciplinary courses that they take as free-electives will help them to abstract the business information and relate to their IT background. These are the important points that support the need for multidisciplinary education.

The departments considered for the vertical multidisciplinary education framework case studies are presented in the next section.

5. THE CASE STUDIES

5.1. The Banking & Finance Department

The Banking and Finance Department in Faculty of Business and Economics is giving masters degree where the deficiency program are shown in Table 4. Since DIT students are taking the must course MATH211 Introduction to Statistics they will be exempted from STAT202. If they take the other two BNFN courses as non-technical electives, there will be only one deficiency course left. This one course can also be taken with the other master courses if the student is being accepted by the department. So there will be no extra semesters for taking deficiency courses in order to begin to the graduate program in Banking& Finance Department.

Table 4: The Banking and Finance Department deficiency program courses

STAT 202	Statistics
BNFN 303	Essentials of Corporate Finance
BNFN 312	Money and Banking
BNFN 302	Commercial Bank Management II

5.2. Economics Department

The Economics Department in Faculty of Business & Economics is giving masters degree and the courses shown in Table 5 are the deficiency program courses. There are no courses that DIT students can be exempted. Although if the students take two courses as non-technical electives, they have to study only one more semester for passing the other two deficiency courses.

Table 5: The Economics Department deficiency program courses

ECON 201	Intermediate Microeconomics
ECON 202	Intermediate Macroeconomics
ECON 315	Mathematical Economics
ECON 310	Econometrics I

5.3. Business Administration

Business Administration in Faculty of Business & Economics is giving masters degree and the five courses given in Table 6 are the deficiency program courses. There are no courses that DIT students can be exempted. So if the students take two courses as non-technical elective, still they will spend 1-2 semesters for completing the other deficiency courses.

Table 6: The Business Administration Department deficiency program courses

MGMT 101	Introduction to Business I
MGMT 201	Principles of Management
MRKT 301	Marketing
ECON 201	Intermediate Microeconomics
FIN 301	Financial Management

5.4. Educational Sciences

Educational Sciences master program in Faculty of Education has three deficiency program courses as shown in Table 7. The student eligible for masters degree has to take these three courses which is one semester for deficiency courses. The students who take two courses as non-major electives can take the third course after being accepted to the graduate program.

Table 7: The Department of Educational Sciences deficiency program courses

EDUC 501	Introduction to Teaching Profession
EDUC 513	Planning and Evaluation of Instruction
EDUC 540	Development and Evaluation of Measurement Instruments

5.5. Communication & Media Studies

Communication & Media Studies masters program of Faculty of Communication & Media Studies has three deficiency courses as shown in Table 8, two of which can be taken as non-major elective and third one after being accepted to the graduate program.

Table 8: The Department of Communication and Media Studies deficiency program courses.

COM 101	Introduction to Communication Studies
COM 102	Communication in History
COM 205	Theories of Mass Communication

5.6. Satisfying the Deficiency Program Requirements

A sensible way of providing the desired flexibility into the DIT curriculum is through introducing a number of free-elective courses. The aim of the free-elective courses is to satisfy the deficiency program requirements presented above so that the DIT graduates can further their education in one of these departments and indulge in a multidisciplinary education framework. This can be very easily done by changing 2 non-technical elective courses and 3 of the technical-elective courses in the DIT curriculum shown in Table 1, into 5 free-elective courses. The number 5 is chosen such that all of the deficiency programs in the cases given above will be considered.

The departments chosen, are the ones that most of DIT students prefer for graduate studies and the departments that have common core courses with DIT. So the three departments are proposed for being the main cases for multidisciplinary education in IT is Economics, Educational Sciences and Communication and Media Studies. The deficiency courses of these departments will be added to DIT's curricula as free-electives, and the results of surveys and the success levels of students will be the outcomes of the proposal which is going to structure DIT's multidisciplinary education framework for future studies.

6. RESULTS AND CONCLUSIONS

Many professional educational institutions fail to meet the target learning outcomes for their graduates. Specially, at the beginning of the 21st century where almost all of the businesses are striving for information, the need to hire IT specialists has reached its peak. More important, the need to professionals with IT specialization is even more severe. Hence, educational institutions must revise their curriculum for addressing these needs and introducing vertical multidisciplinary education systems such that the students, at some stage of their education, will switch from learning Soft Skills and IT skills to professional education, depending on how much IT specialization is required in his/her profession.

Free-elective courses will introduce the necessary flexibility into the curriculum so that the students enrolled in the DIT department will graduate fully prepared to enter the departments M.Sc. or M.A. programs presented in the above case studies.

For a professional IT carrier further surveys must be carried out in order to find out what IT, soft and professional skills are required and how are these skills introduced in the curricula.

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