Information Systems Development Course

Integrating Business, IT and IS Competencies

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Abstract — **Information systems development (ISD) is a capstone course in the Information Systems and Technology undergraduate program at School of Engineering, University of Minho, Portugal. ISD is viewed as an organizational change project that aims at improving an organization through the adoption of IT applications.**

The course is designed following a project led approach. The project involves describing an organization as a system, describing its information handling activities and proposing a set of IT applications that could be adopted and used.

Students are guided by an ISD methodology that demands the application of previous developed competencies in areas such as: organization theory, accounting, marketing, information systems fundamentals, data bases, software engineering, computer networks and several other IT courses. Together with the ISD course, students are also taking courses on organizational behavior and data-warehousing.

Students are organized into large teams of 10 to 12 members. Several roles are distributed among team members: e.g., team leader, analyst, document officer, technology officer, methodologist, development tools specialist, IT specialist.

Students are suggested a fictional organization in a specific business area. Ideally students should deal with a real organization. As the course is having around 100 students enrolled this is not possible. However it is common that each project team finds an organization in the proposed business area where they go and have actual contact with an organization.

The main outputs of the project include: project plan; organization description including – purpose, environment, main activities, business ontology, main performance indicators; general information systems description using UML; requirements for an IT application; IT architecture. One of the most important steps of the project is to decide on what IT to suggest to the organization. The decision should take into consideration the capability of current IT, the specifics of the business area and its current practices.

Besides the reports, each team makes two public presentations. The first one is to present the organization description making sure business is clearly understood. The final one is to present the solution in terms of information systems and IT architecture. These presentations are attended by industry guests that focus their attention on the students' communication skills from the perspective of a manager.

The evaluation of students' performance is based on: reports corresponding to the outputs mentioned above; public presentations; weekly assessments of the teams' progress. The final mark attributed to each team (a numerical value from 0 to 20, where above 10 is a pass) can be re-distributed among team members, by themselves, in order to account for different levels of commitment or effort within the team. Several other rules are set in order to promote professional behavior.

Keywords – IS professionals; capstone course; ISD process; engIS methodology; project led approach; large teams.

I. INTRODUCTION – EDUCATION OF IS PROFESSIONALS

The evolution of computers and computing led to the emergence of several different professions related to the design, implementation and deployment of computer and computing artifacts. The Computing Curricula 2005 [1] distinguishes among such five different professional profiles: computer engineering, computer science, software engineering, information technology and information systems. This article addresses the last of these – information systems (IS).

The education of IS professionals has been much debated (early discussions can be found in [2], [3], [4] or [5]). Besides several individual contributions, it is interesting to focus on collaborative efforts to produce a set of recommendations for IS programs both at undergraduate and graduate levels. Such efforts led to reports such as IS 1995 [6], IS 2002 [7] and MSIS 2006 [8]. A new proposal for the IS undergraduate curriculum is being discussed and should become public early this year (2010) [9].

Based on these recommendations (or, at least, somewhat related to them), many IS programs can be found all over the world. At the AIS site, a list of such programs can be consulted (http://apps.aisnet.org/isprograms).

This article addresses a course on information systems development taught at the 3rd (last) year of an undergraduate degree program on information systems at School of Engineering, University of Minho, Portugal. The learning outcomes of this course include:

- Describe and explain the information systems development (ISD) process";

- Participate in an ISD project carried out in a laboratory setting, performing most activities of the process;

- Describe and explain the information systems development (ISD) process;

- Distinguish between ISD and software development, and between ISD and other organization intervention activities;

- Compare the proposed methodology for ISD with alternative methodologies from literature or practice.

In order to achieve these outcomes, the course was designed according to a project-based approach where students are faced with a fictional organization in whose information system they have to intervene.

II. INFORMATION SYSTEMS DEVELOPMENT

The information systems development (ISD) is a key capability of IS professionals – improving organizations through the adoption of information technology (IT). ISD corresponds to a combination of several of the IS high-level capabilities as described in the collaborative document sponsored by ACM and AIS [9] that is leading to a proposal for an undergraduate curriculum for information systems. Those capabilities include: improving organizational processes, exploiting opportunities created by technology innovations, understanding and addressing information requirements, identifying and evaluating solution and sourcing alternatives.

ISD should not be confused with software development. Software development aims at producing an IT product. It involves setting the requirements, designing, implementing, testing and deploying the IT product. ISD has a broader scope as it aims at improving an organization through the adoption and use of information technology (IT) applications. An ISD methodology suggested to students at University of Minho – engIS – encompasses the following main activities:

- A – understand the organization: the aim of this activity is to produce a systemic model of the organization; the model should address: purpose (a statement of what the organization is supposed to do), environment, activities (main organization activities; a structure of activities such as Porter's value chain is suggested), manipulated objects (inputs and outputs of the organization' activities) and organs (people and machines that execute the activities; the model also addresses the organization's ontology (main business concepts and their associations) and a basic set of performance indicators (it is suggested that the performance indicators are organized according to the balanced score card structure); the outcome of this activity is a report with a description of the organization from a systemic perspective;

- B – understand the organization's information system: based on the systemic description of the organization developed in activity A, a description of the organization's information systems is produced; this description addresses the organizational activities that deal with information; the description is represented with UML – unified modeling language;

- C – define changes to be made to the organization's information system: the organization's information system is reviewed and changes are proposed; ideas for how to use IT applications are discussed; requirements for new IT applications are defined;

- D – obtain IT products to be used in the organization: the purpose of this activity is to obtain the applications whose requirements have been defined in activity C; four different strategies can be used to obtain the IT applications: (i) a software development process carried out by an in house group; (ii) to buy an off-the-shelf product from an adequate supplier; (iii) to hire an external software house to develop the application according to the defined requirements; (iv) to access the application on a service basis from an adequate service supplier;

- E – execute the proposed changes: this activity includes: to implement the changes planned in activity C; prepare the organization for new ways of working; installation and configuration of the IT applications.

To get involved in an ISD project and be able to participate in the activities described above, a large set of professional skills and competencies is necessary. These skills and competencies build upon knowledge related to:

- Organizations and markets – general understanding of organizations and markets;

- Operations and management of organizations – understanding of the major organizational activities both at operational and managerial levels;

- Computers and information technology – understanding the way computers operate and how they can be linked in communication networks; understand how computers and other devices can be connected in order to enable information collection, storage, representation; distinguish among different types of IT applications that can be used to execute/support work in organizations (e.g., data processing, management information, decision support, software); understand the role of platforms that enable IT applications (e.g., databases; workflow management systems, data warehousing);

- Information technology in organizations – understanding the roles played by IT; IT and business opportunities and business models; IT and strategic planning; IT in managerial activities; IT in operations; understand how the success of IT in organizations can be assessed;

- Socio-technical organizational change – understanding the problems of organizational change that involve both people and technology;

- ISD methods – understand ISD methods; use methods, techniques and tools; plan an ISD intervention combining appropriate ISD methods, techniques and tools; assess an ISD process;

- Software development – building software products to execute/support work in organizations; applying methods, techniques and tools for software development; build IT applications of different types, using the platforms mentioned in the previous point;

- Project planning and management – planning a project and controlling its execution;

- Systems thinking and problem solving – thinking about complex active objects; representing systemic models of such objects; using those models to solve problems (either on building IT artifacts or planning changes in organizations).

Besides science and technology skills and competencies, ISD is also demanding in what concerns soft skills, namely:

- Inter-personal communication – listening to others; explaining own ideas; making presentations, writing reports;

- Inter-personal relationships – collaborate with others; team motivation; leadership;

- Professionalism issues – ethics; assess the impact of the work being carried out on people, organizations or society; reflexive attitude towards professional knowledge and action; permanent pursuit of good practices.

It should be recognized that it is not easy to train young IS professionals capable of exhibiting the combined competencies just described. This corresponds to the ability of integrating different subjects and developing a comprehensive perspective of IT in organizations. And besides the intrinsic difficulty of mastering the different subjects in an integrated way, the absence of live experience in an organization of the students adds further difficulty.

III. THE ISD COURSE AT UNIVERSITY OF MINHO

The portfolio of undergraduate programs in computing at the University of Minho offers several education programs in the area of computing, corresponding to several of the profiles presented in the Computing Curricula 2005 report [1]. Among them, the Information Systems and Technology (IST) program focus on the education of IS professionals. In its curriculum, the IST program includes courses that address the areas mentioned above.

The Information Systems Development course is a capstone course. It is taught in the first semester of the 3rd (last) year. It builds upon several other competencies developed along the program. The learning outcomes of this course include:

- Describe and explain the information systems development (ISD) process;

- Participate in a ISD project carried out in a laboratory setting, performing most activities of the process;

- Distinguish between ISD and software development, and between ISD and other organization intervention activities;

- Compare the proposed methodology for ISD with alternative methodologies from literature or practice.

In what concerns the contents, the course covers:

- The information systems development process: conceptual framework; ISD process and other intervention activities; ISD and software development;

- The engIS methodology;

- Social and political aspects of the ISD;

- Professional competencies for the ISD process;

- engIS and other ISD methodologies;

- Representation of information systems: UML and other representation packages; dealing with complexity in information systems representation;

- Techniques for the ISD inquiry process.

Considering the learning outcomes and the competencies and skills that are aimed, the course has been designed following a project-based approach. A project running along the whole semester is a central activity in the course. Each student is expected to dedicate 10 hours per week to the project. The course corresponds to 10 credits (ECTS – European Credit Transfer System) which is twice the common weight of a course.

IV. THE PROJECT WITHIN THE ISD COURSE

A major feature of the course is the project. The project attempts to simulate an organizational situation that a consultancy team will address in order to improve through the adoption of information technology. Ideally, students would be confronted with a real organizational situation. However, considering the size of the class this has been ruled out. The class size typically ranges from 80 to 110. With such size, too many simultaneous cases would be necessary. So, each year a particular business is proposed to students. A notary, a hospital, a university or a rent-a-car are some of the business examples that have already been used. In order to bring "reality" to the simulation, students are encouraged to contact a real organization in the business area that has been chosen. In these real organizations, students have the possibility of experiencing some of the aspects and difficulties of the inquiry process associated to the ISD.

The project doesn't cover the whole ISD process. Only activities A, B and C of the engIS process model. However, students are requested to consider in their work the plan for all the activities. Activities D and E are included in the plan but not actually executed.

Students are organized in teams of 10 to 12. The relatively large size of the teams leads to a situation where students have

to interrelate to with a broader set of colleagues and to carry out work involving a high number of interrelations. Team size is also related with work distribution and coordination. Teams are asked to assign roles to different members. Among the suggested roles the following are the most important:

- Team leader – general work coordination; team motivation; record (diary) keeping;

- Project manager – planning a project and controlling its execution;

- Document officer – keeper of models and other documents concerning the project;

- Methodologist – specialist on the methods and techniques being used; should assure that all members of the team are well aware of the procedures to be carried out;

- Development tools specialist – should try in advance the tools to be used;

- System analyst – carries out general work related with the inquiry process;

- Designer – participates in planning the future of the organization or in the design of computing artifacts;

- Database administrator – responsible for organization's databases strategy including design and implementation if necessary

Project results are presented in reports and presentations. Three main reports are produced: (i) a project plan, produced after the second week; (ii) an interim report delivered on the sixth week and (iii) a final report. Presentations to the faculty, colleagues and guests from industry are made just after the delivery of the reports.

Autonomy and responsibility are key elements in the project. Teams are granted with a high level of autonomy in the sense they can plan their work, they can select methods, techniques and tools. A final mark is attributed to the work produced based on an assessment of the reports and presentations. Regular weekly meeting with faculty are also an input that contributes to assess the way work is being carried out. Based on team's self assessment, the mark is distributed among team members, reflecting their involvement it the project work.

V. REPORTS OF STUDENTS' EXPERIENCE IN THE ISD COURSE

Looking through the student testimonials in the final project reports, it is undeniable the importance they recognize to the ISD course in their education when taken under the already explained project-led learning approach (quotations bellow have been translated from their original in Portuguese in the reports from the past two school years, 2008/09 and 2009/10):

- "The experience we got from this project turned out to be very valuable giving us a clear picture of what may be indeed an information systems development process in reality." (Team 2, 2008/09);

- "I feel quite enriched with this project that got me ready in several ways for market realities." (Pedro, Team 3, 2008/09);

- "All team members consider that this project was crucial for our education and will be very valuable for our professional future." (Team 4, 2009/10);

- "Having been a project quite enriching at several levels, I will highlight the fact that was the closest I came across to market realities so far in my studies." (Margarida, Team 2, 2009/10).

This is not to say that students didn't experience any difficulties such as managing the project complexity and dealing with a large team size in a working context as close as possible to reality:

- "The entire project, due to its complexity, presented some obstacles. First, how to manage a large team since having to coordinate the work of twelve members in a team was a brand new experience. Second, how to organize several reports, what to include, how to justify, how to develop them. Finally, how to deliver two public presentations, if not a major obstacle, at least an important milestone to prepare for and overcome successfully." (Team 1, 2009/10);

- "I would highlight the inexperience in working in such large teams, the difficulty in assigning tasks and reaching team consensus while having to deal with so many perspectives." (Alexandre, Team 3, 2009/10);

- "While working in the project, the team faced difficulties in several areas, namely, in understanding the organization. This is in part explained by the lack of know-how regarding organizational realities (…). Other difficulties came up while designing the IT architecture (…). It should be stressed that quite some effort has been put to manage the project according to what was initially planned." (Team 2, 2008/09);

- "From the moment we really understood which type of organization we had in hands, we started describing the information system using UML while doing a market research on the software packages that could be used in our organization to develop the IT architecture. This was clearly one of the most laborious and difficult stages in the project since none of us had great experience in this type of tasks. Moreover we were getting little or inconclusive information from organizations we were getting in touch with." (Team 4, 2008/09);

- "There were manifest difficulties in understanding and describing the information system because we were used to model a software system, not an information system." (Team 5, 2008/09);

- "We had great difficulties in understanding the organization. It was clear our lack of know-how on how an organization such as a rent-a-car was working," (Team 4, 2009/10).

In spite of all the above mentioned difficulties, and also because of them, students ended up giving testimonials about important learning outcomes that they have reached:

- "We have developed a set of skills in the analysis, evaluation and solving of information systems problems that we were clearly missing." (Team 1, 2009/10);

- "This project has allowed me to get the knowledge on how to develop information systems while applying knowledge from other courses." (Fernando, Team 6, 2009/10);

- "This has been a surprising project since we have been applying what we have learned in other courses over the past years." (João, Team 1, 2009/10);

- "This project allowed us to be involved in a situation requiring the use of methods, techniques and tools while using knowledge from several other courses in the economics and business areas." (Alexandre, Team 2, 2008/09);

- "In practical terms, I was able to increase my knowledge. Although I have learned many things in other courses, I was never able to put them into practice. I should stress that I developed also some skills on how to organize work, work in teams, manage time, understand and solve organizational problems." (Margarida, Team 2, 2009/10);

- "Working in a team with twelve people developed my ability to manage relationships, led me to take on new working responsibilities and carry out work in an autonomous way. I think I am bet prepared to enter the job market." (Rui, Team 2, 2009/10);

- "The project with a large team was quite a challenge in work and relationships management getting us ready for the job market. We were able to apply knowledge already acquired in other courses as well as new knowledge from the course itself, in a practical context, leading to a knowledge consolidation that broadens our working options in the market." (Miguel, 2009/10);

- "I have been able to acquire new knowledge that will be fundamental for my professional future. In addition I was able to expand knowledge I acquired in past courses such as Information Systems Fundamentals, Software Methodologies and Process, or Computers Networks." (Tânia, Team 4, 2009/10);

- "We had come to the conclusion of the importance of having an approach for information systems development as the one suggested by engIS since we were able to develop an information system to improve the work in the organization." (Team 3, 2008/09).

Summing up, having dealt with the difficulties inherent to information systems development projects, the students make an overall positive evaluation of the ISD course:

- "Working in this project made us able to intervene in organizations to develop their information systems taking advantage of information technologies in order to improve organizational performance."(Team 3, 2008/09);

- "To summarize, it should be highlighted that this project has turned out quite valuable allowing us to deal with concepts and techniques in the information systems arena that will be of great importance in our professional future. Our team makes an overall positive evaluation of the project." (Team 4, 2008/09);

- "I will emphasize the experience acquired by working in big teams in a close contact with organizational realities while still in an academic environment." (Bruno, Team 3, 2009/10);

- "This project was essential for acquiring new competencies as well as knowledge that will be needed in the future, either academic or professional. Many difficulties were experienced but once they were overcome, we got substantial gains in technical abilities and knowledge that will be valuable in future works." (Liliana, Team 4, 2008/09);

- "ISD was a course that got me specially motivated allowing a healthy competition among teams in a simulation of what we will have to face in a professional environment. Public presentations in a formal setting having the presence of industry guests contributed decisively for that simulation." (João, Team 5, 2009/10);

- "As it was a project quite "real", that gave me a big motivation to enroll in the course and participate in the project in an extremely active way." (Sérgio, Team 5. 2009/10);

- "It was a marathon, although very tempting, the intervention of a team in an organization to improve its performance using information technologies. It was a project that led us to use collaborative tools, to engage in team debates and apply new knowledge in information systems development." (Guilherme, Team 6, 2009/10);

- "I should stress the importance and high sense of responsibility that we take upon during the semester. It was not an academic project without substance, but one that had to be deeply worked to show real application possibilities."(Diogo, Team 1, 2009/10);

- "The project was quite rewarding and enriching allowing the consolidation of past acquired knowledge in a simulation of what could be a future working situation to get me better prepared for the job market. This project helped me also to develop team working abilities since I had to deal with very different people unknown so far to me" (Raquel, Team 2, 2009/10).

V. CONCLUSION

The ISD project started to be used in the early 1990s. Since then it has evolved, incorporating lessons learned from previous editions and contributions from talks and seminars on project led education, a teaching approach fostered in the School of Engineering at University of Minho.

Licenciatura in Information Systems and Technology – the IS program where the ISD course is taught – suffered in recent years major revisions related to the Bologna process. This led to some changes in the scope of the ISD course and its project. One of the main limitations that is being recognized is that students do not have time to get involved in the implementation of the IT products they suggest in order to improve the organizational situation (students execute only activities A, B and C of the methodological approach they follow, cf. section II). Therefore, adjustments are being prepared to allow students to focus more on developing implementation skills.

The experience obtained so far with the ISD project supports the conclusion of the important role that project led education can play in the education of IS professionals. The project is particularly important when recognizing that IS professionals are supposed to integrated knowledge and competencies from areas such as business, management and information technology and that this integration should happen in a problem solving environment that involves a high degree of human interaction.

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Information Systems Department

Engineering School

University of Minho, Portugal

Information Systems Development Course

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Transforming Engineering Education:
Creating Interdisciplinary Skills for Complex Global Environments,
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Agenda

I.   Education of IS Professionals

II. Information Systems Development (ISD)

III. ISD course at University of Minho, Portugal

IV. ISD Project

V.   Student Testimonials

VI. Conclusions

| IS Education | ISD | ISD Course | ISD Project | Testimonials | Conclusions |

Professional Profiles

- Computer Engineering

- Computer Science

- Software Engineering

- Information Technology

- Information Systems

Computing Curricula, 2005

IS Education	ISD	ISD Course	ISD Project	Testimonials	Conclusions

Information Systems Development

- Part of the Information Systems and Technology 3-year undergraduate program at School of Engineering

- Project-based approach

- Organizational change project to improve an organization through IT applications adoption

- Methodological framework to provide guidance: engIS

- Fictional organization in a specific business area that usually involves close contacts with real organizations in the same area

IS Education	ISD	ISD Course	ISD Project	Testimonials	Conclusions

Learning Outcomes

- Describe and explain the information systems development (ISD) process;

- Participate in an ISD project carried out in a laboratory setting, performing most activities of the process;

- Describe and explain the information systems development (ISD) process;

- Distinguish between ISD and software development, and between ISD and other organization intervention activities;

- Compare the proposed methodology for ISD with alternative methodologies from literature or practice.

IS Education	ISD	ISD Course	ISD Project	Testimonials	Conclusions

ISD vs. Software Development

- Software Development

  – setting the requirements, designing, implementing, testing and deploying Information Technology (IT) applications

- Information Systems Development

  – improving an organization through the adoption and use of information technology (IT) applications

A broader scope

IS Education	ISD	ISD Course	ISD Project	Testimonials	Conclusions

Integrating Competencies

Software
Development

ISD Methods

Organizations and Markets

ISD

Socio-technical
Organizational
Change

Operations and Management
of Organizations

Systems Thinking
and Problem Solving

Information Technology
in Organizations

Computers and
Information
Technology

Project Planning
and Management
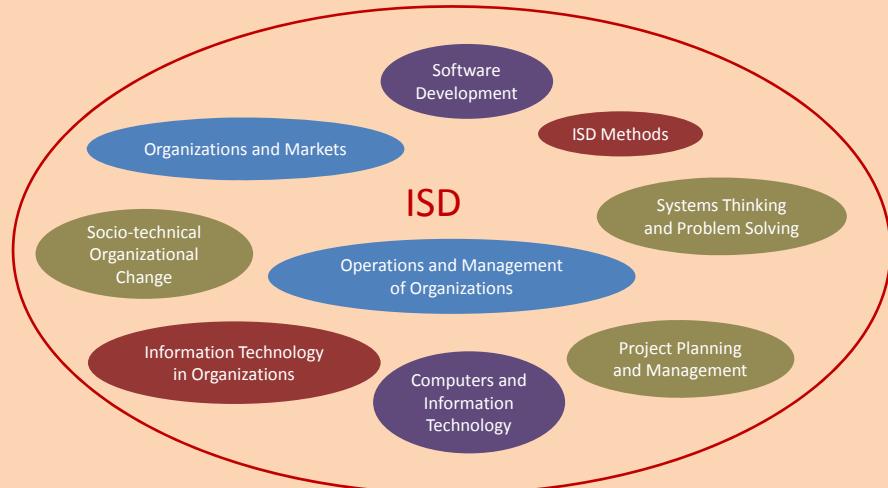
| IS Education | ISD | ISD Course | ISD Project | Testimonials | Conclusions |

Soft Skills

Interpersonal communications

ISD

Interpersonal relationships

Professional issues; ethics
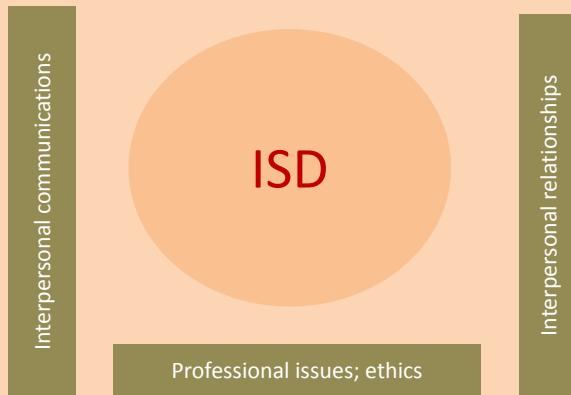
| IS Education | ISD | ISD Course | ISD Project | Testimonials | Conclusions |

Capstone Course

- Last year, 1st semester

- Demanding the application of previous developed competencies, e.g.
  - Organizational theory
  - Accounting
  - Marketing
  - Information Systems Fundamentals
  - Databases
  - Software Engineering
  - Computer Networks

IS Education	ISD	ISD Course	ISD Project	Testimonials	Conclusions

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Scientific Area	Semester 1	Semester 2	Semester 3	Semester 4	Semester 5	Semester 6
Maths and Quantitative Methods	Fundamentals of Discrete Mathematics — 6	Fundamentals of Linear Algebra — 6	Topics in Mathematical Analysis — 6	Operational Research — 5		
				Topics in Statistics — 5		Simulation — 5
Business	Introduction to Economics — 5	Principles of Organization and Management — 5	Accounting — 5	Marketing — 5	Organizational Behaviour — 5	Financial Management — 5
					Logistics and Production Management — 5	
Information Systems	Information Systems and Technologies — 6	Databases — 6		Fundamentals of Information Systems — 5	Management Support Technologies — 5	Information Services — 5
					Information Systems Development — 10	Implementation of Integrated Systems — 10
Information Technology			Software Process and Methodologies — 6			
	Foundations of Computer Programming — 8	Programming Paradigms — 8	Web Programming — 8	Software Development — 10		Knowledge Based Systems — 5
	Computing Systems — 5	Operating Systems — 5	Computer Networks — 5		Distributed Systems — 5	

IS Education	ISD	ISD Course	ISD Project	Testimonials	Conclusions

ISD Methodology: engIS

A. understand the organization

B. understand the organization's information system

C. define changes to be made to the organization's information system

D. obtain IT products to be used in the organization
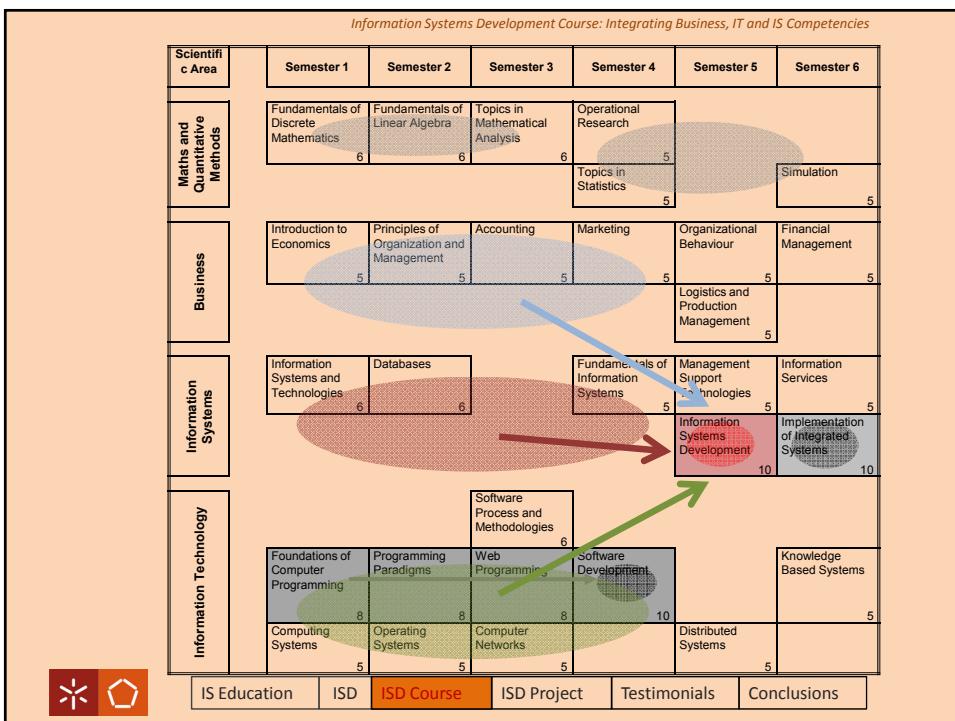
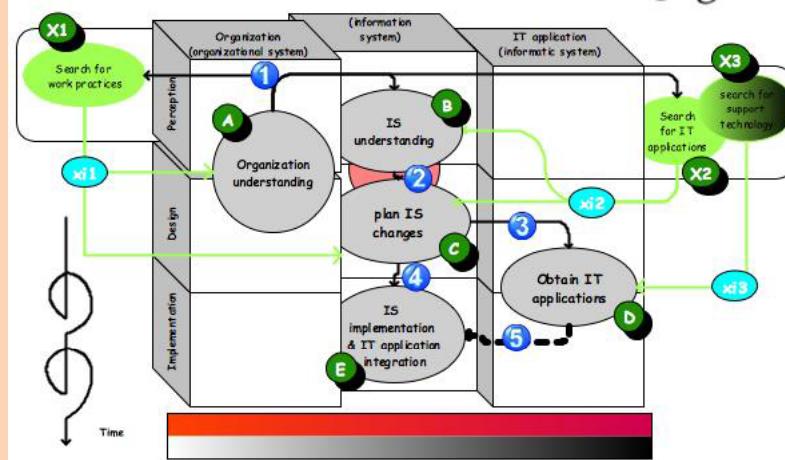E. execute the proposed changes

| IS Education | ISD | ISD Course | ISD Project | Testimonials | Conclusions |

| IS Education | ISD | ISD Course | ISD Project | Testimonials | Conclusions |

Team Organization

- Around 100 students enrolled

- Large teams (10 to 12 students)

- Roles:
  - Team Leader
  - Project Manager
  - Document Officer
  - Systems Analyst
  - Methodologist
  - Development Tools Specialist
  - Designer
  - IT Specialist
  - …

IS Education	ISD	ISD Course	ISD Project	Testimonials	Conclusions

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Project scope
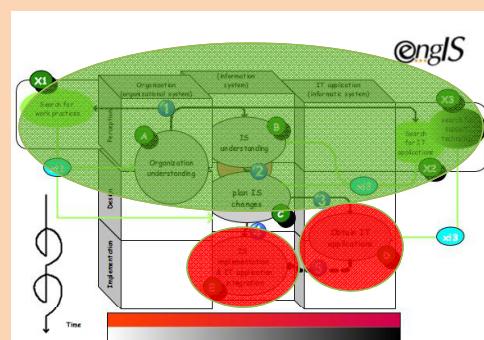
- Organization understanding
- IS understanding
- Plan IS changes

- Included in the project plan but not actually executed
  - Obtain IT applications
  - IS implementation & IT application integration

IS Education	ISD	ISD Course	ISD Project	Testimonials	Conclusions

Project Main Outputs

- Organization description

- Information systems description

- IT application requirements

- IT architecture

- Public presentations

  - Initial: Organization description

  - Final: Information Systems and Technology solutions

IS Education	ISD	ISD Course	ISD Project	Testimonials	Conclusions

Project evaluation

- Weekly assessment of team's progress

- Periodic written reports (five)

- Public presentations (two)

  - External evaluation (industry guests):

    - Particular emphasis on communicative skills, demonstration of organization understanding and business value of proposed solutions, …

- YouTube video

- Redistribution of team final mark among team members

IS Education	ISD	ISD Course	ISD Project	Testimonials	Conclusions

Highlights: sense of reality

- "The experience we got from this project turned out to be very valuable giving us a clear picture of what may be indeed an information systems development process in reality." (Team 2, 2008/09);

- "Having been a project quite enriching at several levels, I will highlight the fact that was the closest I came across to market realities so far in my studies." (Margarida, Team 2, 2009/10).

| ☀ ⬠ | IS Education | ISD | ISD Course | ISD Project | Testimonials | Conclusions |

Challenges: large teams, reports and presentations

- "The entire project, due to its complexity, presented some obstacles. First, how to manage a large team since having to coordinate the work of twelve members in a team was a brand new experience. Second, how to organize several reports, what to include, how to justify, how to develop them. Finally, how to deliver two public presentations, if not a major obstacle, at least an important milestone to prepare for and overcome successfully." (Team 1, 2009/10);

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Challenges: understanding organizations

- "While working in the project, the team faced difficulties in several areas, namely, in understanding the organization. This is in part explained by the lack of know-how regarding organizational realities (…). Other difficulties came up while designing the IT architecture (…). It should be stressed that quite some effort has been put to manage the project according to what was initially planned." (Team 2, 2008/09);

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Challenges: understanding IS, team working

- "There were manifest difficulties in understanding and describing the information system because we were used to model a software system, not an information system." (Team 5, 2008/09);

- "I would highlight the inexperience in working in such large teams, the difficulty in assigning tasks and reaching team consensus while having to deal with so many perspectives." (Alexandre, Team 3, 2009/10);

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Outcomes: integrated competencies

- "This project has allowed me to get the knowledge on how to develop information systems while applying knowledge from other courses." (Fernando, Team 6, 2009/10);

- "This has been a surprising project since we have been applying what we have learned in other courses over the past years." (João, Team 1, 2009/10);

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Outcomes: integrated competencies

- "This project allowed us to be involved in a situation requiring the use of methods, techniques and tools while using knowledge from several other courses in the economics and business areas." (Alexandre, Team 2, 2008/09);

- "Although I have learned many things in other courses, I was never able to put them into practice." (Margarida, Team 2, 2009/10);

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Outcomes: developed soft skills

- "I should stress that I developed also some skills on how to organize work, work in teams, manage time, understand and solve organizational problems." (Margarida, Team 2, 2009/10);

- "Working in a team with twelve people developed my ability to manage relationships, led me to take on new working responsibilities and carry out work in an autonomous way. I think I am bet prepared to enter the job market." (Rui, Team 2, 2009/10);

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Outcomes: team working

- "I will emphasize the experience acquired by working in big teams in a close contact with organizational realities while still in an academic environment." (Bruno, Team 3, 2009/10);

- "This project helped me also to develop team working abilities since I had to deal with very different people unknown so far to me" (Raquel, Team 2, 2009/10).

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Developed competencies

- "Working in this project made us able to intervene in organizations to develop their information systems taking advantage of information technologies in order to improve organizational performance."(Team 3, 2008/09);

- "To summarize, it should be highlighted that this project has turned out quite valuable allowing us to deal with concepts and techniques in the information systems arena that will be of great importance in our professional future. Our team makes an overall positive evaluation of the project." (Team 4, 2008/09);

IS Education	ISD	ISD Course	ISD Project	Testimonials	Conclusions

Developed competencies

- "It was a project that led us to use collaborative tools, to engage in team debates and apply new knowledge in information systems development." (Guilherme, Team 6, 2009/10);

- "This project was essential for acquiring new competencies as well as knowledge that will be needed in the future, either academic or professional. Many difficulties were experienced but once they were overcome, we got substantial gains in technical abilities and knowledge that will be valuable in future works." (Liliana, Team 4, 2008/09);

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Conclusions

- The importance of project led approach in the education of IS professionals

  - To allow for the integration of competencies from different domains, namely, business and information technology

  - To allow for the development of soft skills in problem solving environments, namely, how to manage time, how to organize work with and from multiple sources, how to manage conflicts and reach consensus.

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Conclusions Cont'd

- The importance of project led approach in the education of IS professionals in cooperation with industry

  - To allow for the development of communicative skills and argumentation skills on how to show the value for the business of the proposed solution

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