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A Multidisciplinary Approach to Teach the Design of Socially Relevant Computing Systems for Social Change*

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In recent years many universities worldwide are promoting social-based education models. The Service-Learning pedagogical methodology has been adopted to do that. In computer science education, the Socially Relevant Computing paradigm is gaining inertia. Many discipline-based service-learning approaches in engineering education are focused from the technology-based perspective. That means, the way needs should be fulfilled is through technology conceived and developed perhaps without any societal context. In this paper we propose going beyond this traditional conception. We present a methodology tested for three years on how to teach the design of Socially Relevant Computing Systems for social change. By taking into account a social-based design methodology, named Social Intelligence Design, and a multidisciplinary approach, students from computer-related academic programs can design the social change and see the technology as a mean to accomplish that. Examples of some Socially Relevant Computing systems for social change are provided. We validate our proposed methodology with a questionnaire based on the ABET outcomes. The proposed approach seems very promising to design and conceive Socially Relevant Computing systems within this new paradigm.

Keywords: socially relevant computing; service-learning; computing education; multidisciplinary course; social intelligence design; social change

1. Introduction

Historically, universities have migrated from teaching- to research- and to entrepreneur-based education [1]. Currently, and in response to global challenges such as the economy, energy, climate change, transportation, food, security, etc. to name only few, many Universities worldwide are establishing ambitious programs for a social-based education [2–6]. Furthermore, Universities are showing social university responsibility through the implementation of courses designed under the service-learning pedagogical technique [2, 7] and by promoting social entrepreneurship [7, 15]. The term service-learning describes the educational practice and philosophy of integrating classroom concepts with a related community service experience. It promotes active learning through community engagement and directed reflection. In active learning, the students have an opportunity to learn through hands-on experience, as they would in an internship. Service-Learning benefits are many and varied but the quote from Honnet and Poulsen summarizes them very well: *'Service, combined with learning, adds value to each and transforms both'* [8]. Service-Learning is considered a subset of Experiential Learning [9].

Institutions, departments and faculty practice service-learning in different ways and granularities. Experiences ranges from one-time service activities to individual courses with a service component, to sequences of courses centered on long-term service projects. The relationship of the service component and the learning component can also vary widely. The Sigmon topology of service learning [10] uses the terms service-LEARNING, SERVICE-learning, service-learning, and SERVICE-LEARNING to indicate the relative emphasis, balance and connection between them. Moreover, there are six recognized basic models of service-learning [11]: pure service-learning courses, discipline-based service-learning, problem-based service-learning, capstone service-learning, service internships and action research. In general, service-learning follows the four phases of the Kolb Learning Cycle [12]. The phases in sequence are: concrete experience, reflective observation, abstract conceptualization, and active experimentation.

In computer related education, the author in [13] noted the lack of visibility for computer science courses in terms of service learning projects: *'Computer science is not very visible in the service-learning community. Similarly, service-learning is not very visible in the computer science education community'*. He also proposed a classification of computer related projects in service-learning [14]: develop an information system for an organization's administrator; develop a web site for an organization or school; develop a classroom software for a school; network and organization's computer resources; tutoring and other instructional activities. The opportunities listed above outline a traditional scope of a technology-based service learning project. Dif-

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ferent other projects can be introduced using computer or related technology; however this may require faculty think outside of what is traditionally taught in a technology training course.

Recently, service-learning for computer science has gained a lot of attention under the name of Socially Relevant Computing (SRC) [35–37] [45]. SRC is a unique paradigm in computing, it focuses on the use of computation to solve problems that students are most passionate about. It presents Computer Science as a cutting-edge technological discipline that empowers them to solve problems of personal interest, as well as problems that are important to society at large. SRC emphasizes the use of computation for solving problems of personal and societal interest to students. It offers opportunities to demonstrate that Computer Science is a mainstream endeavor and that it offers conceptual and technological tools for solving meaningful, real-world problems. Courses in this new framework help students identify and model tasks, and design and implement computational solutions that show deep understanding of their embedding in the real world. At the very least, SRC offers interesting examples to illustrate foundational concepts in Computer Science. By emphasizing problem-solving, and by giving students practice in recognizing needs and engineering solutions to them via computation, SRC at its finest promises to create a more entrepreneurial, as well as a more broadly educated Computer Scientist. SRC can be classified as a discipline-, technology- and problem-based service-learning approach.

This paper proposes a multidisciplinary approach to teach the design of SRC systems for social change. It goes beyond the approaches presented above in the way technology is viewed as a mean to transform the society and computer-related students are viewed as designers of social transformation by means of interventions in society through the design of computing systems. Therefore, in this paper we see SRC systems as means of society transformation through which the individuals interact and gain social intelligence. The methodology imposes multidisciplinary work in classroom at two levels: students and professors. It also includes many product design methodologies and the use of social-centered design approaches (an extension of the human-centered design approach [40]). The paper explains two academic experiences carried out during the periods January–May 2008, 2009 and 2010 and August–December 2010. The multidisciplinary component promotes Cross-Disciplinary Learning (CDL) [44]. Such experiences are requirements for accrediting agencies like the Accreditation Board for Engineering and Technology (ABET)—Computing Accreditation Commission (CAC) [16] and the ACM/IEEE Computing Curricula [17].

2. Institutional context

Important foundations for the ambitious task of a social-based education are educational innovations [5]. Tecnológico de Monterrey System has been working on this since 1995, developing and enhancing its own pedagogical model. For instance, at the end of 2007, there were almost 14,000 re-engineered courses under Tecnológico de Monterrey's own educational model (70% of all courses taught at Tecnológico de Monterrey System). Each re-engineered course implements recognized teaching practices like Project-Oriented Learning (POL), Problem-Based Learning (PBL), the Methodology of Cases, Collaborative Learning (CL). Since 2007 the Service-Learning and Research-based Learning techniques are being promoted. Additionally, Tecnológico de Monterrey has declared a Quality Enhancement Program (QEP) oriented to the development of students' competencies in two important ways: ethics and citizenship [18]. The core element of Tecnológico de Monterrey's educational model is the change of the teaching and learning roles. Students become more active in their learning, whilst teachers guide or facilitate the student-learning process. We believe that this important role change is one of the keys for social-based education.

With respect to Computing Education at Tec de Monterrey's System, all Computing related programs are considered under the umbrella of Information and Electronics Technologies. All Computing related programs were reviewed during 2004 based on technology trends, new trends in curricular models (i.e. Career Space Consortium), international accreditation agencies (i.e. ABET/CAC), and last but not least ACM/IEEE Computing Curricula. From this revision four Bachelors of Science programs were created; among them the Computer Science (ISC), the Information and Communications Technologies (ITIC), the Information Systems Management (LATI) and the Electronic and Computer Engineering (ITE). An important innovation in these four programs was the inclusion of several integrating courses distributed almost every three semesters.

2.1 Academic programs involved

The integrated course presented here has been initially offered to ITE students but students from ISC and ITIC programs are invited to take the course as an elective. In some of the academic experiences there were ISC students and some ITIC students. The course is integrated with a workshop for Industrial Design students (LDI). During the first experience the number of computer-related students was 20 and 24 from industrial design. During the second experience they were 24 computer-related students and 22 from industrial design. During the third experience there were 24 industrial design students and 22 computer-related students divided in two groups of 12 teams and finally during the fourth experience there were 24 industrial design students and 8 computer-related students. All students are from the senior level (they are in the seventh or sixth semester of nine). Very little are from the junior level. The course presented in this paper can easily adopted by other computer-related disciplines where social change through technology creation is the main objective.

3. Service learning in computing

We describe here the most important works related to frameworks and general aspects of computer science service learning. In [22], the author introduces a service-learning taxonomy that is well suited for the information sciences discipline. Additionally, the author suggests that the service component should be oriented toward specific projects that address significant information technology needs of Non-Profit Organizations (NPOs). Also, the author provides a summary of key student benefits. In [23], the author highlights the domains of the learning outcomes, which are: technical knowledge, social knowledge and personal knowledge. In [26], the author expresses the main problems why service learning has not been implemented in computer science widely, they are: lack of time to reflect, lack of time to deliver an ended product, asymmetrical service-learning, overhead of the instructor, students must have some previous experience and certain level of knowledge and abilities, and the lack of continuity and maintenance of the problem. Many articles have been published about service-learning in computer science. More examples of computer science service learning can be found in [13–14, 19–33]. An up to date list but not vast at all of computer related service learning papers can be found at [46]. In these papers many issues have been addressed such as how service learning has been incorporated into the computer science field, incorporation of real-world problems into course learning objectives, acquiring practical work experience, low student interest and retention rates, improving students' communication skills, enhancing students' documentation skills, reducing security risks and teamwork.

Based on the state of the art presented above and to our knowledge, we did not found any paper describing the teaching process on how to design SRC systems for social change. Our paper can be considered as the first to present a social-centered design methodology for SRC systems. Moreover, almost all of the service-learning methodologies in computer science intend to develop systems for particular needs (lower Maslows' scales). We believe that to cope with current global challenges socially relevant computing systems should be designed taking into account the social capital of the individuals using by them (upper Maslows' scales). To accomplish this, a social interaction design paradigm must be taken into account. In the next section we introduce a framework to do that.

4. Socially relevant computing systems for social change

In the computing world, it has been discovered that the social approach encourages students to develop solutions to socially relevant problems [35–37, 45]. In this paper we take another approach for SRC. Our foundations are based on the following argument which states that in order to cope with global challenges, it is necessary to enhance the SRC paradigm with the development of higher order cognitive skills (HOCS) on the society. In another work [47], we proposed systemic thinking as a way to sustain a sustainable design of everything created by humans. In that work, the focus is on engineering and design education of undergraduate students. We proposed a tool for evaluating the systemic view gain of systemic interventions in classrooms. This paper goes in another direction which is about how to design SRC systems for social change. Therefore, in the following we describe the foundations of the social design paradigm we propose for the integrated course.

Within the design world, Social Design (SD) refers to shape social products and social services. Other definitions refer to SD as the creation of social reality or design of the social world. SD is sometimes defined as a design process that contributes to improving human well-being and livelihood [34]. In our course we decided to use a SD paradigm called Social Intelligence Design (SID). SID attempts to integrate and understand the interactions between designing and social intelligence. It involves multiple disciplinary approaches concerning design and implementation of systems and environments, ranging from group/team oriented collaboration support systems that facilitate common ground building, goal-oriented interaction among participants, to community support systems that support large-scale online-discussion. SID also involves processes associated with the cognitive and social psychological understanding of social intelligence, providing means for predicting and evaluating the nature and consequences of media on the nature of discussions, interaction dynamics, and decision making. It encompasses also pragmatic considerations from economy, sociology, ethics and many other fields, for social intelligence design has a direct relation with the society. For SID, all these aspects work complementarily to each other and must be integrated intimately, for good systems cannot be built without good understanding and vice versa [38]. SID characteristics are exhibited at several granularities: social interaction, collaboration and social network. Examples of SID characteristics at the granularity of social interaction are: believability, awareness, likeability, gaze, intention, richness, etc. At the granularity of collaboration some examples are: persuasion, trustworthiness, knowledge transfer, teamwork, etc. Finally, at the granularity of social network some examples are: leadership, reputation, group development, etc.

Through the SID paradigm, students will design SRC systems able to promote interaction among social groups but also to promote one or several SID granularities (e.g. HOCS). Moreover, the SID paradigm facilitates the integration of computer-related students (ISC, ITIC, ITE) and LDI students in multidisciplinary teams. In traditional engineering design courses, a final project is developed only from the technological point of view. If the final goal of engineering design courses is to improve our society and to provide a technological solution to social problems the students are obligate to understand social change/evolution and therefore developing social and human capital on them. The SID approach allows us to meet both requirements. Moreover, by integrating the two courses mentioned above and around the SID paradigm, we promote a desirable approach to our QEP engagement. We also approach real life work as well as product innovation in computing-related and LDI students. We assume that SID-based products and systems are relatively new as serious products in the market. Many examples can be found in the gaming sector. Figure 1 shows a general model of social change (SID granularity) with social interaction through a SRC system.

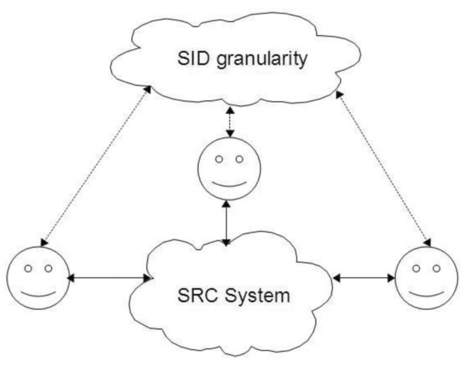

Fig. 1. A general model of social change (SID granularity) through a SRC system with social interaction.

A SRC system can be a social network platform or application for fixed or mobile computers, or an interactive sculpture for increasing the awareness of sustainability. Some examples of SRC systems developed in our courses will be explained in the following sections. A distinction of our approach is outlined here. Traditional service-learning for computer science has been focused on the technology-based development of computing systems or SRC systems (e.g. Human Computer Interaction). The main focus of our course is on the social change (e.g. SID granularity). Then technology becomes a mean to accomplish that goal and not the goal itself. This paradigm shift is one of the main contributions on the students' engineering education.

5. On teaching the design process of SRC for social change

Four academic experiences have been executed during the January–May 2008, 2009 and 2010 and August–December 2010 semesters. In Table 1 we present our general course schedule compared with other engineering philosophies, the service-learning cycle at Tecnológico de Monterrey (QEP) and the Kolb Learning Cycle.

5.1 Team building

In the first experience we used an empirical methodology for team building. We formed teams of two or three computer-related or LDI students then we put face-to-face teams of computer-related and LDI students and giving them some time to know the team in face. At the end of the session students marked their preferred other specialty team. Teams were formed according to students' preferences. Since the second experience we used two tools: the Speed Teaming methodology [39] and the individual theme of interest. In the Speed Teaming methodology students interview other disciplines' students during two minutes then they make a choice of several partners by preference. This methodology is a modification of the famous Speed Dating methodology. Once the students prioritized three themes of interest and their preference partners we used information from all academic methodologies to compose the teams.

5.2 Theme choice

During both experiences initial themes were proposed by professors. In the first experience we limited the themes to four SID application domains. They were: workspaces, education, entertainment and digital cities. In the second experience we proposed the following themes: employability, se-

Table 1

Framework	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
QEP (service-learning at Monterrey Tech)	Social problem formulation	Solution proposal	Planning & executing proposal	Assessment of social impact	Reflection from the experience	Ability to argue and use sources of information
Project Management	Defining the project	Planning the project	Executing & Controlling the project	Delivering the project		
Engineering Design Process	Identifying the need and defining the problem	Conducting research and Analyzing set criteria	Finding alternative solutions, Analyzing possible solutions and Making a decision	Presenting the system / product, Communicating and Selling the system / product		
Kolb Learning Cycle	Concrete Experience (social) and Reflective observation	Abstract conceptualiz-ation	Active experimentation (AE)	AE	AE	
Integrated Course	Social problem research	Concept generation	Concept development	Concept presentation	Concept evaluation	Concept documentation (research paper)

curity, health, social emotion, sustainability, education and transport. One important thing to mention is that sustainability was the most selected choice among students.

5.3 Social problem research

To search social problems, beginning with the chosen theme, students use the mindmap technique and the questions technique. Innovations in this stage consist in the way mindmaps and question techniques are developed. They are developed collectively. Once they have a focus on their mindmap they use IDEO Cards [40] and apply ethnographic research to answer the questions. By applying these techniques they come up with a social problem. All this information helps students make their hypothesis. It is worth saying that by taking the SID approach many innovations come up since there are not a lot of commercial products/systems designed under this paradigm. In this sense students have the opportunity to innovate a new product during the process.

5.4 Concept generation

During all experiences, similar methodologies were used to generate the idea. They were: scenario creation, story boards (SB), use-case diagram and flow diagram. They created individually several SID-based scenarios (one per user), then they integrated in a SB all the scenarios created by their colleagues. Once the SB is integrated, students identified scenarios where actors interact with the SID-based system and they formalize with the use diagram. The use diagram is also known as use-case diagram in informatics [41]. During the second experience the participation of ITIC engineers have enriched the course dynamics since they have additional technological tools, for instance they are using Unified Modeling Language (UML) to formalize their use-case diagram. Also since EE students do not have sketching abilities, we proposed to use the Comic Life™ platform. Flow diagram is used mostly for engineers. It is used for programming hardware or developing software. Engineering students were requested to develop their flow diagram.

There are two ways of solving an engineering problem or giving a solution to a need: convergent and divergent. In the divergent form the problem is well established (i.e. requirements, use-cases, etc.) and the main work is to explore the best solution. In the convergent form, there is not a well defined problem (e.g. wicked problems) and the main work is to converge towards a well defined one. In the divergent form, ideas generate more ideas while in the convergent form, ideas are selected and refined. The divergent form is also known as elaboration, the convergent form is also known as reduction. In general, in designing a new SRC system the form is convergent and is composed by several loops of divergent-convergent activities. For instance the mind mapping activity is a divergent and the choice of one of the line of thinking is a convergent. Figure 2 shows a representation of the main convergent form for social problem research and concept generation. It is composed by several sub-stages of exploration and decision making (not all the stages of the course are represented). Beyond training the students in practicing divergent and convergent thinking they are trained in the tools and processes to conceive SRC systems for social change. We start from nothing; everything is created through the process.

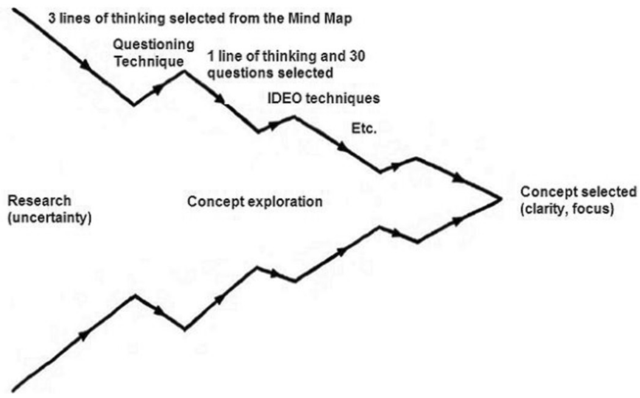

Fig. 2. A representation of the main design process followed in the integrated course.

5.5 Concept development

In this stage, both types of students agree on the main keywords of their work and develop a collective image board. Then LDI students develop several sketches and agree with computer-related students. Once they agree, sketches are transmitting the ideas, they are separated in a similar way as the concurrent engineering approach suggests. Computer-related students built a prototype and LDI students build a mockup of the concept. This is, in our opinion, the most important stage of the course. We must remember that students are learning. During both experiences computer-related students show some kind of anxiousness since they are often educated to give a software/hardware solution without spending a lot of time on the design. To deal with this phenomenon we talked to them and explained carefully that every new product has its first prototype and that it does not have all the functionalities of the ideal concept. They started to understand that the main functionalities give personality to their products and that they must concentrate on them. They also become aware of the complexity of the engineers' real life. During the first experience, computer-related students used previous knowledge about microcontrollers or digital electronics such as FPGAs. Furthermore, depending on the project they also learned from new technologies (especially wireless). At our engineering school professors teach 8051^{TM} architecture and some students have the AVR^{TM}, Motorola ^{TM} or Microchip^{TM} experience. Last semesters most of the concepts have been implemented in the Arduino^{TM} platform [42]. The ideal result would be that students make at least two turns on their prototypes so they could be aware of versions or product generations. For the ideal concept computer-related students cooperate with specifications (mainly dimensions) and LDI students develop a real model (with exploded view and CAD information). On the other hand for the prototype, LDI students develop necessary mock ups and computer-related students develop functionality. Both prototypes are presented during the Engineering Division Fair.

5.6 Concept presentation

At the end of each stage, teams are requested to present the deliverables developed during their corresponding period. This also enforces delayed teams to finish their work and present it. Also, at the end of the semester, teams are requested to present their work during the Engineering Division Fair. Deliverables are the stand design, poster design (both publicity and scientific), videoprototype design and brochure.

5.7 Research paper

Teams are asked to prepare a research paper as a final deliverable. As we are designing social products under the SID paradigm, our course is adapted to submit the concept developed by the students. During the first experience we requested the whole article at the end of the experience. Last semesters year, we are requesting advancements every evaluation period. This effort pioneered the Research based learning pedagogical technique declared recently at Tecnológico de Monterrey System.

5.8 Evaluation

Several evaluations have been applied every month. During the first experience, we developed rubrics for each stage. We were three professors, two from LDI and one from the ITE. It took too much time to achieve and to reach an agreement. Work was evaluated mainly based on presentations. When concurrent engineering was applied each subteam was evaluated in a separate way. Since the semester January–May 2009, we have enriched the way we evaluate. First, we applied collaborative learning assessments in order to get the meta-knowledge desired. In fact, we started to redesign the course under the Collaborative Learning technique since it is a granularity of SID and since we found it to be a good SID tool [43]. Second, we added Cross Disciplinary Learning assessment developed by Renate Fruchter [44] [50]. Third, we are adding individual assessment each period in order to evaluate the students′ learning process. Another important change is that we are inviting researchers and professors to the presentations and taking into account their grades. Evaluations consist of 10 minute presentations with no questions. Students should be able to give concrete information during this time. In the first experience, we invited a researcher from the MIT Mobile Design Experience Lab and in the last years within our Academic Leader Program we received the visit of Lorraine Justice, Director of the School of Design from the Hong Kong Polytechnic University and some others with the intention to give feedback to our students.

5.9 Technology

Most of the re-engineered courses are implemented in BlackBoard™ platform but according to our experience this platform is still very rigid for the richness and spontaneity of the course. Therefore, we are promoting the use of new free web-based platforms where students keep information from their collaborative work (e.g. Ning, Facebook, etc.). Most of the teams have found the Stixy platform very friendly. We also have an agreement with IUSACELL™ so many students use their BlackBerry™ Smartphone. We also invite the students to use Google Docs™. Currently we are testing the Ning™ social network platform.

5.10 Interactions at the professor level

Most of the design process described here is oriented to students. Nevertheless, many interactions occur between instructors. An important innovation in our setting is the instructors' attitudes towards the project. There are at least two instructors per course, each one from different disciplines [19]. The role of instructors is to guide the students' learning process of designing a SRC system for social change. Instructors meet every week in order to design and adapt the course and to discuss it. It has been a very enriching environment from both sides. Through our interaction we discover that self-motivation for learning and project self-engagement are of the most valuable attitudes in this kind of courses.

6. Results

First we present briefly five examples of systems developed during the courses. Complete documents and more examples can be consulted in [48].

6.1 Example 1: A family emotional communication wireless system

The project tries to solve the problem of family disintegration, from a SID perspective. Due to the lifestyle and the many activities that have to be done by each member of the family, there is little time to interact, and communication becomes too cold. The solution is the design of a system that allows family interaction, through the use of a device called YUNIT. This device allows each family member to send his/her emotional mood to someone else, creating an emotional communication. Since physical contact is also a human need which increases life quality, YUNIT recreates it by suffering a physical transformation when it is in contact with the hand of the receiver. All the information exchanged between family members is registered in a server at home, which is located in the refrigerator. The system works with WiMAX technology, which works with wireless internet. This system has the purpose of joining design and technology, to help family members communicate, increasing union between them, and therefore creating social networks through emotions.

6.2 Example 2: Social intelligence design development in the tourism industry

In recent years, the tourism sector has been experimented a big diversification becoming one of the most important economic sectors in all nations. In this work the authors proposed an information network and physical modules intended to be used by tourists in a city. The name of the system is ICNELIA. This is a kind of blog where tourists help tourists to enhance the social intelligence of them. In particular the SID granularity is the membership to a group. This social characteristic is experienced by tourists. The help and social cooperation through communications channels will impact the emotional experience of the tourists.

6.3 Example 3: Social- based employability module for workers who don't have access to technology

This project presents a SID approach to reduce the rate of unemployment among the people who don't have a professional degree and are unable to reach technology. The project is called Joby, it is a system divided in two parts. The first part is an electronic module located in public areas and has easy access. Workers and employers can get in contact through the modules. The second part of the project is a web site, where employers with internet access can also get in contact with the workers. The SID granularity promoted here is reputation. It is expected that through reputation, employers will select workers in a more fair form giving opportunity to all the workers.

6.4 Example 4: Urban reflector: social integration of homeless children

This research work deals with the inclusion of homeless children in citizenship-based activities. By means of a wireless device that is offered to the homeless children they could report to the competent authority any anomaly related to the life in urban cities. By means of the Urban Reflector project, homeless children develop their social abilities and it is expected they will feel more integrated to the society. The SID granularity is citizenship and belonging to a social group. Both granularities are key issues to develop better citizens. Through the Urban Reflector system, homeless children acquire more important roles than those currently used. The system might provide statistics about participation of homeless children in bettering their community.

6.5 Example 5: TAI: A social-aided transport system for the blind and visually disabled

By means of ethnographical research, students come up with social problems for disabled people. They decided to concentrate in blind or visually impaired people because they are almost 5000 in our hometown. Of the major problems for blind people is transportation. Visually impaired people in developing countries lack of a system to transport. Students proposed a social-based system and bus stop as a solution. The social scheme is supported by an electronic system to record the most common preferences and schedule the bus stops of the chosen route to travel, so the user, disabled or not, does not have to worry about missing the bus anymore. A muck-up of the bus stop was built and a small scale functional prototype was developed to show the proof of concept.

6.6 Experiences

By applying the SID paradigm we found that three levels of SID are promoted: the SRC system (prototype or project), the students' social process and the professors' social process. These social processes add social capital [6] to our undergraduate students and to us as professors [49]. Six students' projects from the first experience were published in the seventh international workshop on SID in December 2008, six in November 2009 and three in September 2010. It is almost a year project. One team from the first experience was working towards incubation and others expressed their idea about patenting. Two of the teams are working on their implementation for product innovation. During the second experience we used extensively Google Docs™ for applying online questionnaires. At the end of the course we applied several questionnaires one of them related to the basic ABET criteria and complementary issues. We also invited professors from other departments to evaluate the projects and act as external constituencies. The list and description of all the projects developed by our students can be found at [48]. The questions were related to the ABET accreditation outcomes. We added questions about innovation and creativity as well as entrepreneurship.

To validate our work we propose a rubric based on the ABET outcomes; a questionnaire with the outcomes was applied during and after the final presentations, to students and to visitant professors. We consider ABET outcomes good enough challenges to assess our work. Moreover, they are a complete set of outcomes comprising the basic abilities undergraduate engineering students should have. ABET outcomes must be considered essential for those academic programs seeking accreditation in USA or international accreditation. It is important to mention that Querétaro Campus has been visited since 1992 and last year we received the first non-US full accreditation. In Table 2 we present the average self-perception of the computer-related students and the average faculty evaluation. The students answered the questionnaire individually; professors answered the questionnaire per team. Some questions related to ABET outcomes were separated in the students' questionnaire to clarify them. The number 5 is the maximum and best value the students can select and means totally agree. Outcome (d) was not requested to faculty since the group is multidisciplinary by nature. Outcomes (a) and (j) were not requested to faculty this time.

Table 2 shows that according to visitant professors almost all outcomes are met. Students also have a self-perception to accomplish the outcomes through the design process learned.

Table 2. Average self-perception and faculty perceptions of the project

	Questions (outcome)										
Integrated course	**1 (a)**	**2 (b)**	**3 (c)**	**4 (d)**	**5 (e)**	**6 (f)**	**7 (g)**	**8 (h)**	**9 (i)**	**10 (j)**	**11 (k)**
Self-perception	4.1	4.4	4.4	4.8	4.6	4.5	4.4	4.7	4.4	4.5	4.5
Faculty	NA	3.8	4.5	NA	4.5	4.7	4.6	4.7	4.4	NA	4.4
Average	4.1	4.1	4.5	4.8	4.6	4.6	4.5	4.7	4.4	4.5	4.5

7. Conclusions and future work

In this paper we first presented a general overview of service-learning in computer science education and its recent recognition through the name of Socially Relevant Computing (SCR). SRC has gained a lot of attention on recent years because the tremendous impact it can have in computer science education. Then we presented our institutional context where we remark that the ISC, ITIC and ITE academic programs are all computer-related and were born mainly from the ACM/ IEEE Computing Curricula. Then we presented a state of the art of the main frameworks and aspects related to this paper. We found that our contribution has not been considered yet. Our main contribution in this paper is the proposal for a design process of SRC systems for social change. We presented the main frameworks and tools used to teach this design process. We also presented a social design paradigm that we were used during two academic experiences and that we found very adequate for teaching SRC systems for social change. The social design paradigm is Social Intelligence Design (SID). In the presented model (Fig. 1) we can distinguish that the focus on the design is the SID granularity instead of the technology capability itself. SID is adequate for our proposal since it is based on social interaction. A main difference among Human Computer Interaction (HCI) and SID is that SID assumes a good HCI and goes beyond. The SRC system should be transparent and as much as natural for the users. In the following we presented the design process of SRC systems for social change. We presented a comparison between the main processes taught at the school, to say: project management and engineering design. We compared both with the Kolb Learning Cycle and the QEP project. The design process for social change is in general of the convergent form with several steps combined of divergent and convergent. As results we presented three examples of SRC systems intended to develop a SID granularity. The granularities of those systems were proposed after the reflective observation. They were chosen based on the potential social change within the studied group. To validate our design process we proposed a rubric based on the ABET outcomes, this is the approach we consider since Querétaro Campus is seeking its first non-USA full accreditation by ABET. Querétaro Campus has been visited by ABET since 1992. In Table 2 we showed that almost all outcomes are met with a good level of accomplishment, in overall average and for students and visitant professors. In particular the outcomes 6, 8, 9 and 10 are related to social contribution of the project.

This paper is the first approximation to the design of SRC systems for social change. Many work still to be done to present a more formal validation of the proposed design process. In particular, much work must be done to evaluate the SRC systems developed by the students (product level). Moreover, a lot of work still missing to evaluate the students and professor's level. At the students level we have done our first evaluation of the CDL [50]. Another effort has been done in evaluating the creativity of the groups [51] and the systemic thinking evolution [47]. Therefore we still working in developing an assessment framework that includes the three levels that SID enables in our setting. Our current and future work is focused on assessment methodologies.

In general, through personal communications with our students we perceive them very happy and enthusiastic with the model, and have expressed a positive experience independent of their evaluations. Some of them finish their experience with the intention to build their enterprise, patent their concept or look for any kind of continuation. The most important index that shows to us that the concept of our students and the process we are following is improving is that the SID research community has appreciated the results. From ten concepts submitted to the seventh international workshop on SID, six were accepted for publication. From eleven concepts submitted to the eight international workshops on SID, six were accepted for publication. Finally, in the 2010 international workshop, three of ten concepts were published.

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