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TOWARDS A CULTURE OF PREVENTION: INCLUDING DISASTER MANAGEMENT IN ENGINEERING UNDERGRADUATE PROGRAMS

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Abstract

The earthquake of 2010 revealed that Chilean communities were not well prepared to respond to large magnitude disasters. There is a long history of destructive earthquakes and tsunamis in Chile that local engineers have been able to take into consideration when designing buildings and facilities and that scholars have studied profusely. However, the knowledge produced by researchers has not been properly transferred to the communities.

With this diagnosis in mind, the Faculty of Engineering of the Universidad Católica de la Santísima Concepción (UCSC) decided to incorporate subjects related to disaster management cycle in the curricula of Civil Engineering and Geological Engineering. For that reason, a course was designed to providing basic knowledge about disaster management.

The course's design included national and international experiences regarding the disaster management. The course seeks to initiate the culture of prevention in engineering students, considering the role they may have to face within the community during an emergency due to their job positions and academic background. This course has been offered for three consecutive semesters and recently it has incorporated practical activities through the application of service-learning methodology.

This article describes the entire experience of implementing this course in the regular curriculum of both undergraduate programs and the challenges related to performing real multidisciplinary project in collaboration with a community.

Keywords: Culture of prevention; Service-learning methodology; Undergraduate Engineering Programs.

1. Introduction

Chile is located along the subduction zone between the Pacific and South American plates. Consequently, its geography, history and culture have been drawn by major geological disasters (earthquakes, tsunamis, volcanic eruptions and others). In this context, Concepción area has been hit by at least 6 destructive earthquakes since its foundation in 1550, including two mega-earthquakes in the last 60 years, the M9.5 Valdivia earthquake in 1960 and the M8.8 Maule earthquake in 2010, both followed by destructive tsunamis.

Since 1974, the National Emergency Office of the Internal Affairs Ministry (ONEMI) is the government agency dedicated to disaster management in Chile. ONEMI is responsible for the coordination of the National Civil Protection System and its mission is to plan, promote, coordinate and implement actions of prevention, response and rehabilitation in situations of collective risk, emergencies, disasters and catastrophes of natural origin or caused by human action [1]. This agency recognizes as one of its most important missions to educate the population in matters of self-care through programs such as "*Chile Preparado*" (http://www.onemi.cl/chile-preparado). Also, ONEMI developed campaigns in collaboration with various public institutions for strengthening preventive behaviors. Nevertheless, experiences have demonstrated that a culture of prevention against natural and man-made disasters is still scarce among communities. Indeed, the social impacts that the Maule earthquake in 2010 created which exceeded what could be expected as a simple consequence of destruction are evidences of this situation. The lack of official and community organization enhanced problems associated to help distribution and security during the first response [2].

Even though, the mission of risk mitigation has been entrusted to the ONEMI, the Universidad Católica de la Santísma Concepción (UCSC) has taken as its own the task of educating and informing community about hazards and vulnerabilities in the Concepcion area. UCSC considers evident the need of establishing preventive policies and actions to promote a culture of prevention that helps to reduce the risk in communities. Thus, since 2014, a course has been incorporated into the curricula of Civil Engineering and Geological Engineering. This course aims to raise awareness in the students about the importance of creating a culture of prevention in their communities and the role they have as professionals in dealing with disasters. It is considered that civil and geological engineers have the appropriate expertise for leading response and mitigation actions in disaster situations. Therefore, it is a responsibility of the University better prepare them to face this task. This article describes the entire experience of implementing this course and the challenges related to performing real multidisciplinary project in collaboration with a community.

2. An overview on Disaster Management

In Chile, disaster management is relevant due to the large number of hazards in the national territory, such as geological, volcanic, seismic and hydrometeorological hazards [3]. These hazards cause events, such as earthquakes, volcanic eruptions, tsunamis, river floods, droughts and hailstorms. Throughout the history of Chile, these natural hazards and local communities' vulnerabilities are the factors that trigger disasters, affecting the activities of its inhabitants and causing considerable damage on infrastructures and services [4].

In recent years, earthquakes and tsunamis are the kind of disaster that most concern the Chilean society. In the recent past, catastrophic events have produced a high cost in lives, thousands of survivors with psychological and physical injuries, severe damage on critical infrastructure and thousands of people losing their houses. The risk of disasters increases when social vulnerability and natural and human hazards are combined in a given geographical area. Hence, the disaster risk management should be approached from a multidisciplinary perspective because of variety of the vulnerabilities and hazards causes.

In 2009, UN-FAO defined hazard as "phenomena, substance, human activity or dangerous condition that can cause death, injury or other health impacts, as well as property damage, loss of livelihoods and services, social and economic disruption, or environmental damage". Depending on the origin of hazard, this can be classified as natural or anthropogenic. UN-FAO also defined vulnerability as "the characteristics and circumstances of a system or community that make them vulnerable to the damaging effects of a hazard". Thus, vulnerability is linked to the social processes taking place in the area exposed to natural or manmade hazards. Usually, vulnerability is related to the fragility and lack of resilience of population to face these hazards. Therefore, the

severity of the disaster depends on potential hazards existing in the geographical region, the vulnerability of communities, and the disaster management that institutions have implemented to reduce vulnerabilities in the geographical region to be protected [5].

In Chile, the National Civil Protection Plan [6] recognizes three stages in the cycle of disaster risk management: Prevention, Response, and Recovery. In the Prevention stage, all the efforts are focused on decreasing or eliminating the risk, minimizing the effects on people, property and the environment that can generate a natural or anthropogenic phenomenon. This first stage in the cycle has four sub-stages: prevention, mitigation, preparedness, and alert. The Response stage includes all the efforts to carry out immediately after a disaster event occurs. The focus of this stage is saving lives, reducing the impact on the affected community and reducing losses. The last stage, Recovery, aims on returning to the previous state of development in the affected area. This last stage includes sub-stages of rehabilitation and reconstruction.

This cycle of disaster risk management seeks to reduce vulnerabilities and increase resilience capacities in institutions and communities. However, this is not an easy task, it require that the entire community, industry and government agencies achieve a culture of self-care and risk prevention. Additionally, disaster situation cannot be handled with the resources and normal procedures [7-11]. Therefore, professionals should be prepared for such situations or events; even though, they are less frequent in the practice of their professional life. The different disciplines of engineering contribute in different parts of the cycle of disaster management in order to reduce the risk of disasters in communities, either by reducing vulnerabilities and/or modeling hazards. For this reason, it is relevant to inculcate the importance of prevention activities in the training of future engineers, because they will be exposed to lead response and mitigation actions in disaster situations.

2.1 Comprehensive School Safety Plan

The school and nursery safety policy of prevention promoted by the Ministry of Education aims to enhance and strengthen a safe and protective environment in all educational institutions in Chile. The Ministry of Education approved in 2001, through Resolution No. 51, the Comprehensive School Safety Plan (*Plan Integral de Seguridad Escolar*, PISE) developed by ONEMI. This resolution makes mandatory the creation of a PISE in all the educational institutions in the country and it must be adapted to the particular conditions of risks and resources of each school [12].

PISE aims to formalize the actions and define the persons in charge of each activity to face a disaster event in schools. This plan seeks to prepare and improve the response of students, teachers and staff to a catastrophic event. In order to create this PISE, ONEMI proposes two methods to consider: AIDEP and ACCESS.

The AIDEP method is an Spanish acronym for sequentially performing of five activities: (i) a historical analysis indicating the hazards that affect the educational institution; (ii) a field research reviewing the school facilities to detect vulnerabilities in the building and environment; (iii) a discussion and analysis to systematize the perceptions of hazards, external and internal safe areas, and additional information; (iv) the development of a map which purpose is generating a visual display of the safety features and emergency exits; and finally generate, (iv) an action plan for each of the hazards and vulnerabilities discussed in the educational institution.

The ACCESS method is an Spanish acronym that indicates to develop six actions: (i) definition of types alert and alarm; (ii) definition of communication and information channels; (iii) definition of criteria for assessing the coordination plan; (iv) definition of decision makers during a disaster; (v) definition of methods how to evaluate success of the plan; and (vi) definition of the period for the next plan review.

3. An overview on Service-Learning

Service-Learning is an educational method that incorporates activities of community service in the academic curriculum. In these activities, students use contents and academic tools associated to a course for responding to genuine needs of a community [13]. The reflective process that follows the activities is the fundamental element that connects the learning of students with the service [14-15]. This methodological approach requires the presence and participation of three key players: instructors, students and community partners. The essential feature that highlights Service-Learning is solving real social problems through quality service, in which the

three actors are linked and work together in a collaborative manner [16]. The Faculty of Engineering of UCSC adopted this methodology because it promotes professional training and human values, improving engagement and effective links with the community [17]. At the same time, Service-Learning aims on increasing the effectiveness of training and meaningful learning of engineering students [18]. Having all the previous, the Faculty of Engineering established in 2013 the Center for Service Learning and Integration of Knowledge (ASIS Center), which is responsible for training, coordinating, organizing and evaluating the service learning activities developed in the Faculty.

Service-Learning as a methodological approach can contribute much in educating communities, through experiential learning that benefits all the participants [19], and it is known for delivering tangible products to the community [20], promoting the mutual transfer of learning. In UCSC, products of the courses that have adopted this methodology are linked to the service made by the students, the learning outcomes considered for the course and the needs of community partner. Among these products it can be mentioned: diagnostic reports, innovation projects, topographic surveys, risk maps, teaching support materials, software development, databases, training and consulting.

3.1 Implementing Service-Learning in the course of Natural Disasters and Culture of Prevention

As indicated above, the ASIS Center implements learning service by running four essential stages: diagnosis, planning, implementation and evaluation.

In the diagnostic phase, the center identifies courses in the Engineering Programs that could provide opportunities for developing Service-Learning experiences and generate a catalog of potential services that could be presented to community stakeholders. At the same time, ASIS Center organize meeting with different community stakeholders to identify their needs. The planning stage arises once a course that involves Service-Learning methodology meets with a real need of community. In this stage, the service to be developed in the course is defined by specifying functions, deadlines, commitments of the parties and the services to be provided by students. This agreement is officially formalized in a public ceremony with the attendance of all stakeholders and a university representative (Fig 1).

Fig.1- Agreement signature ceremony.

In the implementation phase the intervention planed by the students and their instructors are applied. The progress of student learning and community service is controlled through preliminary reports of site visits, interviews and technical meetings with the community partners. Each implementation is accompanied by reflective activities.

The evaluation stage comprises the application of three survey instruments aimed at community partners, students and instructors. The questionnaire is focused on determining whether the service-learning method allowed the achievement of the course learning outcomes. This outcomes are classified in disciplinary knowledge, personal and interpersonal skills, and community relations. These data are systematized and analyzed to improvement future experiences of Service-Learning.

In the case of ongoing course (Natural Disasters and Culture of Prevention), the community need identified by ASIS Center was presented by the Talcahuano´s Municipality Department of Education Management (DAEM). Talcahuano´s DAEM requested support for reviewing and updating the Comprehensive School Safety Plan (PISE) of schools under its administration. The Service-Learning agreement was signed by a representative of Talcahuano´s DAEM in the role of community partners, the Principals of three schools of Talcahuano in the role of beneficiaries, and the course instructors (UCSC academics) as representative of the University and students.

4. Description of the course of Natural Disasters and Culture of Prevention

Natural Disasters and Culture of Prevention is defined as an integration of knowledge course according to the curricular structure of academic plans established by the UCSC. The purpose of this kind of courses is generating interdisciplinary work to develop transversal skills in students such as autonomy, self-learning and collaborative work. It is an elective course with workload of four teaching hours per week. This course has been offered to third and fourth year students of the Civil Engineering and Geological Engineering Program. The learning outcomes of the course are: (i) Provide a basic knowledge about disaster management considering the national and international experience and in the context of the regional situation, and (ii) foster among students a culture of prevention considering the role would have to play in the community during a situation of disaster.

Figure 2 shows the organization and the time assigned to different topics of the course. This course includes practical activities, lectures related to concepts of risk disaster management and lectures related to different kind of hazards. In the first part of the course, an academic from the Disaster Management Observatory explained and discussed the basic concepts related to risk of disaster management that include disaster management cycle, vulnerabilities and hazards. Also, this part of the course incorporated a talk offered by the Disaster Manager of the Municipality of Talcahuano City that explains the main activities development in the community to reduce the risk of disaster. The second part of the course includes a series of lectures offered by academics from the Disaster Management Observatory and the Civil Engineering Department. Each academic developed a one week module to explain and discuss a specific natural hazard from a technical point of view (earthquakes, tsunamis, volcanism, landslides, droughts and floods). In these technical presentations essential concepts were reviewed to handle the language associated with these events and technical information was retrieved from literature, journals articles and the webpages of official agencies. This information expanded the scientific knowledge of students on these issues.

In parallel to the first and second part of the course, a Service-Learning project was initiated. During the second semester of 2015 (August to December), the project assigned to the students of the course was the reviewing and improvement of the PISE of three schools depending of the Talcahuano Municipality (Santa Clara Primary School, Buena Vista Primary School and Almirante Pedro Espina Ritchie High School). The PISE for the schools of Talcahuano city are particularly important because several schools were deeply affected by the M8.8 Maule earthquake in 2010. Fortunately, these events occurred during holiday season and schools were closed. However, it is capital that schools have an appropriate structure and plan to respond to such kind of disasters.

The Service-Learning project consisted on identifying vulnerabilities and hazards that affect a community, analyzing the potential mitigations and proposing actions to enhance resilience. The third part of the course was completely focused on the development of the service-learning project. The fist activity of this project was an initial visit to each school which was performed to identify hazards and vulnerabilities in those facilities. For this activity, students prepared a questionnaire to interview school authorities, collect information and analyze the area where the school is located using maps and satellite images. An instructor accompanied to each team in the first visit to the school. Later, students visited their assigned schools several times by themselves to improve and to verify the information given by authorities and the current PISE (Fig. 3 to 5).

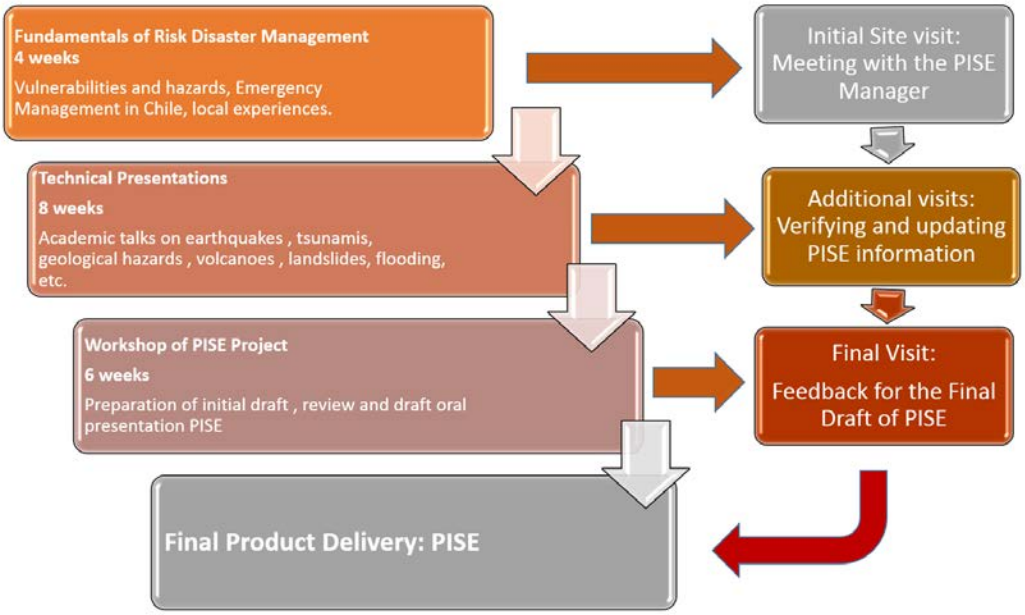


Fig. 2 Course organization

Fig. 3 - Students and instructor meeting with directors at Santa Clara School, Talcahuano.

Fig. 4 - Site visit of students with the PISE manager at Buena Vista School, Talcahuano.

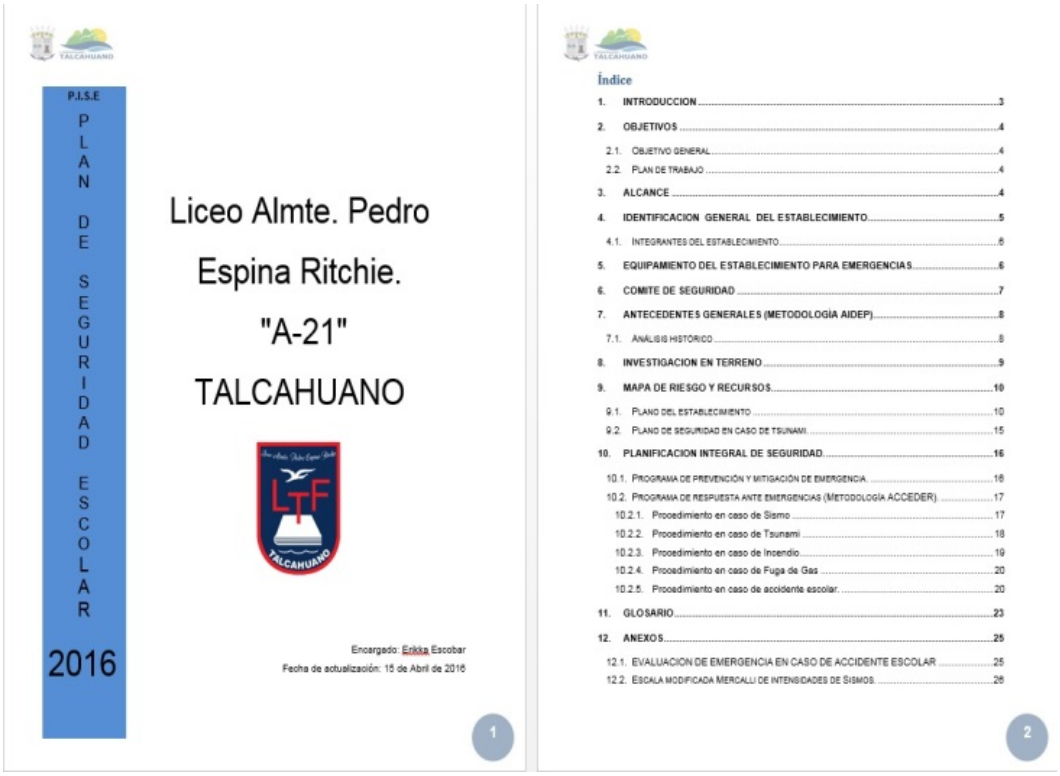
Fig. 5 – Site visit of students with the PISE manager at Buena Vista School, Talcahuano.

A preliminary report is produced, informing the hazards and vulnerabilities identified in each school and its environment. The students had also to present an oral report of their main conclusions to the class. The course instructors gave the corresponding feedback to improve and another week was given to improve the reports.

After this report, students initiated the work on preparing a new version of PISE. A first draft was prepared by each group and workshops were organized for debugging, modifying and improving the PISE up to a high level of quality. An additional visit was made to schools to obtain a final draft PISE which incorporated feedback given by instructors and school community. This final draft was reviewed by the three instructors successively, to ensure product quality. The reports were returned to students and extra time was given to get missing information from schools and to make changes accordingly. Finally, the drafts were submitted to the PISE managers of each school for his/her consideration.

At the beginning of the next academic semester the students contacted schools and visit them accompanied by their instructors to receive the final commentaries about the draft of PISE. Final corrections were incorporated to the document to produce the final version of the PISE (Fig. 6).

PISE were delivered to schools in a ceremony at the University. Representative of each group gave a presentation to the school authorities, Talcahuano´s Municipality representative (DAEM and Emergency Management Municipal Office) and regional officials of ONEMI. In this presentation, the most important aspects of the information collected from each school were presented along with recommendations to mitigate risks (Fig. 7).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PLAN DE SEGURIDAD ESCOLAR
2016
Liceo Almte. Pedro Espina Ritchie.
"A-21"
TALCAHUANO
Encargado: Erikka Escobar
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Fig. 6 – Cover and Table of Contents of PISE for
Almirante Pedro Espina Ritchie High School, Talcahuano.

Fig. 7 – Final Ceremony with the school and municipality representatives.

5. Experience Results

The application of the Service-Learning approach to the engineering courses of the Faculty of Engineering at the UCSC generated an effective link between academy and community, increasing the effectiveness of the teaching and meaningful learning.

In different stages of the course, we applied instances of reflection, which included open creative questions to be answered by the groups and individually. These instances of reflection showed whether students were achieving the course objectives, highlighting attitudinal learning outcomes, such as professional responsibility, adaptation to change, and spirit of service.

We applied at the end of the course a survey to our students to know their perception regarding to some aspects of their experience in the course based on Service-Learning approach. The survey had three sections. The first part was related to general information about the students, the second section concerned about the knowledge and disciplinary reasoning, personal skills, interpersonal skills and CDIO context [18]. The third section asked for comments and suggestions to improve the learning experience. In total, the students answered nineteen questions using a Likert scale of five dimensions (strongly agree, agree, in disagree, strongly disagree and not applicable).

All the students were agree or strongly agreed that service-learning approach allowed them to apply concepts, methods or tools of discipline in an actual problem, and improve the learning process. In addition, they valued the instances of reflection and feedback in each stage of the course. Similar results were obtained for vocational training aspects, as shown in Fig 8.

The survey for course instructors was compound of thirty eight questions divided in four dimensions related with Service-Learning methodology, student skills development, community service and link with community. Also, it included a section for comments and suggestions to improve the experience. The survey was applied to course instructors at the end of service learning activities. They valued the service-learning approach because they noticed that students gain experience in the application of technical aspects and the community partners

increased the relationship with the university. Also, instructors were interested in repeat the learning service experience in the next versions of the course. Finally, when the products of service learning course have been delivered to the community partners, a survey was applied to them to capture the assessment about role played as a partner, service satisfaction and opportunities to develop more projects. Their perception of the service was favorable because it allowed them to update the PISE and they value the participation of the universities in these activities, and they appreciated the universities be concerned about their closer communities.

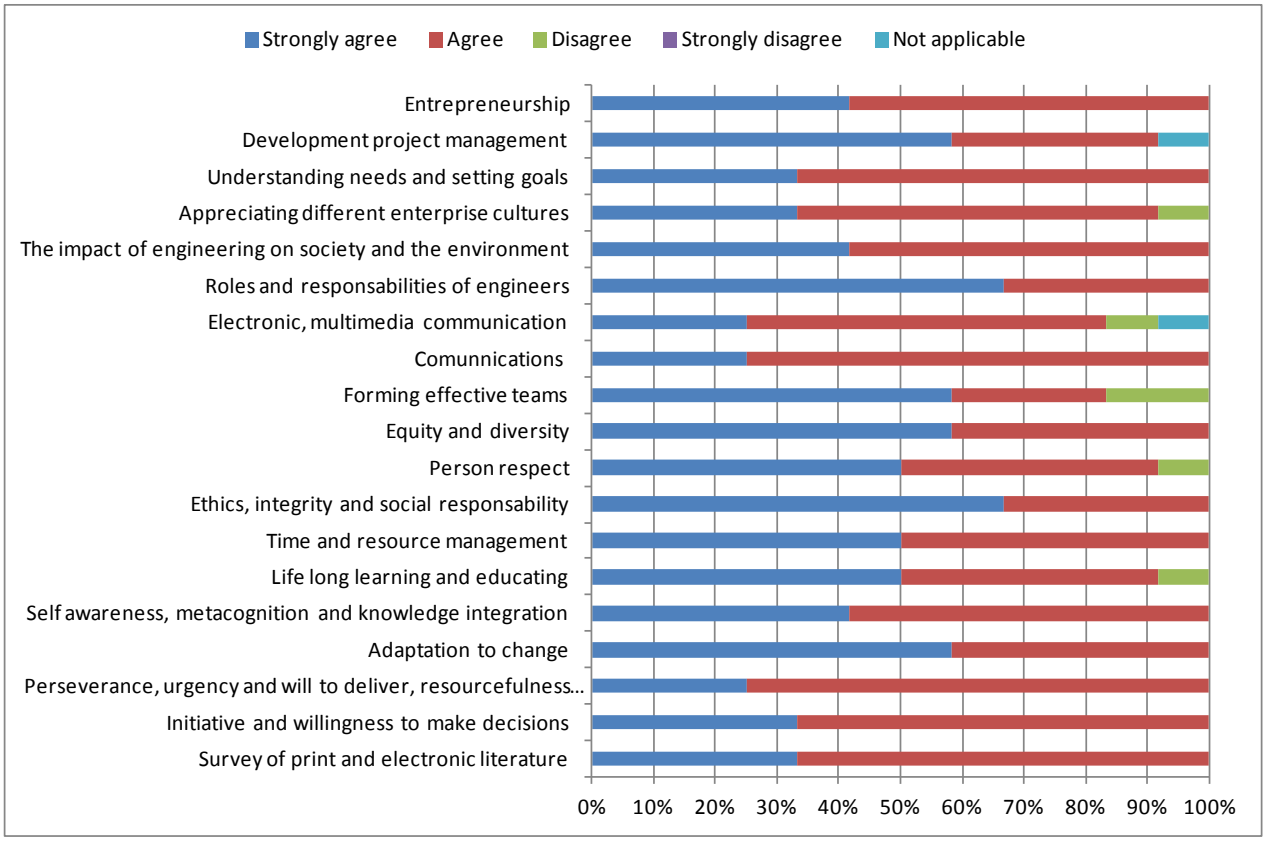

Fig 8 – Student opinion regarding the value of Service-Learning experience in their professional training.

6. Conclusions and Future Work

A direct benefit of the application a Service-Learning approach to the course of Natural Disasters and Culture of Prevention was the update of the PISE of the educational institutions selected by the DAEM of Talcahuano city. This result was an effective way to support the community in their preparedness and education in disaster management.

The indirect, but no less important, benefits of the application of the Service-Learning approach, are described in the following paragraphs:

(i) Students were exposed to the reality of the public schools which was often precarious with regard to prevention and preparedness to face a disaster. Students acquired a social commitment to their academic work, proposing activities beyond the course requirements, such as extra visits to the schools for improving their vulnerability analysis, and proposing several actions to reduce them. This benefit provided an integral development of future engineers and contributed to the social commitment of students.

(i) Students raised awareness about the proper identification of hazards and vulnerabilities to evaluate associated risks. Students also realized that they can be agents of change by intervening in the

community to reduce disaster risk at the macro and micro level. In addition, students took consciousness that engineering projects not only have technical impacts but also have social impact.

(ii) Students learned regarding to organizational structure and functions associated with disaster risk management at national, regional, and community level. In addition, students understood the necessity to have robust structures to address risks in a country with a great diversity of hazards and vulnerabilities like Chile.

(iii) Academics generated a more direct relationship with the community, adapting their knowledge to real problems presented by the community partners. It allowed the transference of knowledge from academia to the society, and additionally, it helped to develop transversal social skills in students.

Finally, next versions of course Natural Disasters and Culture of Prevention are expected to include interdisciplinary approach. We will open this course to students from other engineering disciplines and to students of the Education and Medicine Faculty. Moreover, we are searching for new community partnerships, so we could develop other types of projects in the area of disaster management.

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