

# Design Thinking as a Methodology for Solving Problems: Contributions from Academia to Society.

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**Abstract**– *This article presents how undergraduate students from different disciplines can develop multidisciplinary skills applying the Design Thinking methodology during the Analysis and Problem-Solving course offered at ESPOL. We describe three specific cases in which students propose innovative solutions for Ecuadorian NGOs’ problems. During this process, we evaluated the ability to work as part of multidisciplinary team, an institutional learning outcome developed through projects along the course.*

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## I. INTRODUCTION

Higher education institutions are constantly looking for ways to enhance specific skills measured through student learning outcomes, with the purpose of preparing them for their professional life. By using Design Thinking methodology, students can develop abilities needed in the workplace in terms of innovative contributions. Design Thinking promotes creativity and problem solving [1], while building cognitive and social skills. Moreover, it allows students to think critically about their own problem-solving process. For these reasons, institutional educations are adopting Design Thinking into their curricula [2], [3].

The d.school at Standford University was the first school to incorporate Design Thinking in order to educate students from different disciplines to work together in the resolution of problems, through a human-centered approach [4]. The Design for Extreme Affordability course, for instance, seeks to aid the world’s poorest citizens by designing products and services in a multi-disciplinary project based experience. Since the goal is to achieve actual implementation of crafted solutions, the course successfully brings together students, teachers, global partners and users, breaking the usual confinements of academia.

A similar approach is pursued at Escuela Superior Politécnica del Litoral (ESPOL) in accordance with Ecuadorian higher education governing bodies [5], which has included the Analysis and Problem-Solving course (APS) as a general requirement for all incoming students. The main purpose is to strengthen higher education by educate future professionals focused on developing skills to improve their impact in society [6]. This gap has been identified during the development of advisory committees at ESPOL, which are spaces where the industrial and non-profit sector meet with academia in order to identify skills and needs expected in students when they finish

their careers. One of these issues is problem-solving skills. To meet this need, APS courses were implemented to provide and evaluate solutions to specific non-governmental organizations (NGOs). Using Design Thinking, this class seeks to develop innovative proposals to solve real-life problems in partnership with non-governmental organizations. In this way, bidirectional benefits are obtained: contributions to student learning outcomes and tangible solutions for collaborating NGOs.

The aim of this study is to focus on students’ ability to work in multidisciplinary teams, one of our institution learning outcomes, using Design Thinking in APS courses. This paper contains the following sections: an initial review of concepts on Design Thinking as a methodology for problem solving and its relationship to multidisciplinary teamwork; then, its application and assessment in APS courses, comprised of undergraduate students from different fields of study at ESPOL. Subsequently, we will focus our attention on three specific cases in which innovative solutions to NGO’s problems were proposed. To close, conclusions and recommendations from an educational point of view will be suggested for future improvements in the process.

## II. LITERATURE REVIEW

### A. Design Thinking

Many theorists have attempted to define the concept of Design Thinking. At its most simple interpretation, it involves thinking like a designer [7], [8], or as Brown explains, developing “designer’s sensibility and methods” to meet people’s needs with the available technological and financial resources [8]. Lockwood considers it a “human-centered innovation process” in which several key players come together in an integrative problem-solving course of action [9]; Chao understand it as a combination of “creative and analytical approaches [that] requires collaboration across disciplines” [10]. Bearing in mind our goal of developing multidisciplinary skills in students, the methodology of Design Thinking in the classroom seems appropriate.

Several Design Thinking models are used today, ranging from three to seven stages of development [11]. IDEO’s CEO Tim Brown proposes a three-phase model that includes 1) “Inspiration” or identification of a specific opportunity or problem to ignite action; 2) “Ideation”, or the proposal of possible solutions; and 3) “Implementation”, or testing of ideas

in real-life scenarios [12]. An extended approach is presented by the Hasso-Plattner Institute of Design at Stanford (d.school) [13], suggesting five stages: Empathise, Define, Ideate, Prototype, and Test [11]. Finally, UK's Design Council describes a four-step process that is flexible enough to adapt to specific project specifications: Discover, Define, Develop and Delivery. Given the shape of its mapped structure, it is often referred as the "Double Diamond" model [14]

Evidently, the mentioned models share common aspects as we explore each step. The "Define" or "Inspiration" phase is basically used to identify the main problem at hand after previous user and market research has been conducted. The Double Diamond "Develop" stage combines both the "Ideate" and "Prototype" modules from the d.school, since a product or service is expected to be ready for delivery at the end of this phase [14]. To finish, a concluding evaluation of the solutions takes place in each of the final steps described. For this study, we developed an alternative Double Diamond structure that includes terminology used in similar models, to provide implicit information to students as they tackle each step (Fig. 1):

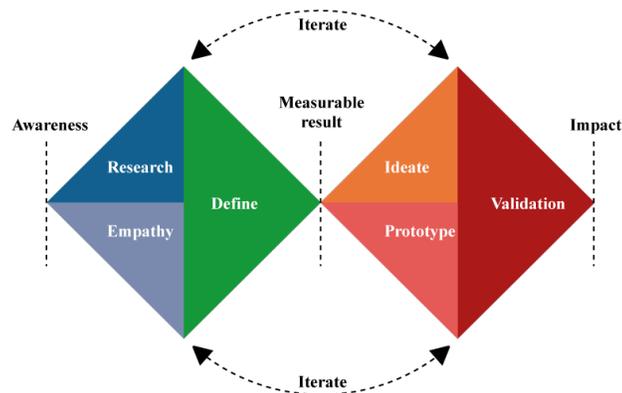


Fig. 1 Design Thinking Double diamond scheme applied in ARP courses.

Notice the diverging and converging instances of the process. Initially, the scope widens to include input from users, market trends and clients, through primary and secondary research. The resulting information is then synthesized into detailed findings known as "Insights" [15], later to expand again to reach out possible problem solutions, and contract once more to deparure prototypes and conclusive results. Theoretically, the model promotes cross-functional and cross-departmental collaboration in students, as a variety of capabilities are assembled.

### III. METHODOLOGY

To develop skills in students by applying Design Thinking and allowing them to propose possible solutions to real-case problems, the methodology was structured in three phases: (i) Identification and description of real cases in Non

Governmental Organisations, (ii) Design Thinking process and (iii) Evaluation of Learning Outcomes.

#### A. Non-Governmental Organizations (NGOs)

This work was conceived in collaboration with two main NGOs given their interest in constructing projects linked to the endogenous development of the community: *In Terris Foundation* and *Benemerita Sociedad Protectora de la Infancia* (Children Protection Society). These NGOs are established in the coastal city of Guayaquil, the most populous city in the country operating in different social projects.

1) *In Terris Foundation* promotes the consumption of organic products, which are cultivated in an environment-friendly manner. *In Terris* runs, together with local high school, an environment-friendly trade fair called Bonaterra. It is the first and largest fair of its kind in the city, bringing together agro-ecological farmers and environmental-conscious consumers [16]. Twice a month the foundation runs the Bonaterra fair offering a direct contact between farmers and consumers, promoting the benefits of consuming organic agricultural products, as well as creating awareness related to the environment.

Despite the good reception of the target audience, there is a concern on the sustainability of the fair, seeking to improve the customer's experience as well as maintain regular clients and capture new ones. According to this need, the following cases were proposed:

*Case 1. How to improve the customer's experience of the Bonaterra Fair?*

*Case 2. How to increase the flow of customers to the Bonaterra Fair?*

2) The *Children Protection Society* works with a project called Hogar Inés Chambers, a shelter that receives children and adolescents between 2 and 15 years of age from unstable families and in need of protection [17]. This institution seeks to integrate a community of donors to permanently meet the children's need. Donations are an important source of income for projects to meet specific needs, with an enormous potential but not sufficiently used. There is no plan or strategy to retain donors, which is reflected in having only two main donors for many years. Also, donations do not always meet the specific needs, which means that communication and relationships between the institutions needs improve. Therefore, the case proposed in order to develop alternative solution is the following:

*Case 3: How to increase the number of donations for children in the Hogar Inés Chambers?*

#### B. Design Thinking process

##### 1) Team building and problem selection

The initial step is to have a dedicated in-class space to explain the Design Thinking process to students, including its stages and proper tools, to allow an iterative development of

suitable solutions. Thirty-two sessions of three hours each were planned for the semester, where teachers would emphasize the importance of innovation and Design Thinking based on Stanford's d.school principles [4]. In each session, facilitators would demonstrate different tools, to later allow students to partake in activities related to the tool. These activities would reinforce our multidisciplinary goal

In addition to teacher-guided activities, students would participate in a final group project, comprised of 5 to 6 students from different fields of study. This project would tackle a real-case problem of our collaborating NGOs, through the application of Design Thinking tools. For this purpose, facilitators would contact potential organizations prior to the beginning of the semester to establish problems suitable to students' abilities and time constrains. During the first weeks of the course, students perform secondary research on these organizations and identify three tentative problems, ranked according to their interests. A visiting NGO representative joins one of the session to answer questions and build empathy, before students select a problem to solve. This way, students have an initial idea of every issue proposed before selecting the final problem.

APS courses were formed with 17 students of different careers (Fig. 4). To construct the cases, students and facilitators visited the organizations to observe and interview users relevant to the problem selected *in situ*. Six visits were arranged in order to gather information and discover the real needs. Students made additional visits on their own, as required by each case.

### 2) Design Thinking in action

Our chosen approach to apply Design Thinking into APS courses is the adapted Double-Diamond model. The course initially defined the concept of innovation and presented leadership characteristics, as well as human-centered design solutions. The following sessions centered on facilitating Design Thinking tools, considering the Double-Diamond stages: Research, Empathy, Problem Definition, Ideation, Prototyping and Validation. Each session would start with a description of objectives in using a specific tool, following a breakdown of steps to allow its application. Sessions would take the form of workshops, promoting a learn-by-doing environment while improving certain skills that students already possess using Design Thinking.

Simultaneously, as students explore each tool, they were able to incorporate them into their group projects. The main objective was to propose innovative solution with the definition and re-definition of the problem, considering research and empathy tools to understand real problems. In this way, every tool learned theoretically could be applied practically in real-case scenarios.

More specifically, students would identify a detailed problem by defining three key elements: the user, its needs, and insights. Once the problem was clear, students were expected to generate as many ideas as possible using brainstorming, alternative worlds, systematic and inventive thinking (SIT),

importance-difficulties matrix, Insights/design principals/solutions/opportunities matrix, just to name a few. Guided by relevant insights and design principles, students then selected tentative solutions to continue onto the prototyping phase. Given some resource limitations, a high-fidelity prototype was not expected, although students were given instructions on how to do so. When prototypes were completed, possible users tested them. It is important to mention that this final validation phase was mandatory for every team since it allowed students to modify, improve or even change the final idea, while giving them arguments to keep or discard the proposed idea.

### 3) Alternative solutions

After potential users validated the proposed prototypes, NGOs involved were able to get the projected results in pitch form from every student group. In this way, solutions were evaluated not only by teachers but also by NGOs representatives. Since our goal in including Design Thinking techniques was to evaluate students' ability to work as part of a multidisciplinary team, facilitators used qualitative rubrics to measure this institutional learning outcome.

Figure 2 summarizes the phases that allowed the generation of innovative solutions using Design Thinking.

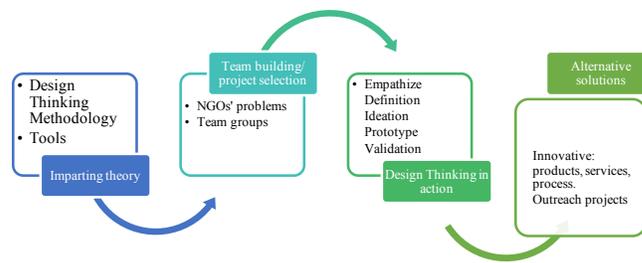


Fig. 2 Phases of the proposed methodology in APS courses.

### C. Evaluation of Learning Outcomes

In terms of multidisciplinary abilities to be developed in APS courses through Design Thinking techniques, a detailed measurement tool is available for students at ESPOL. In 2012, the school's academic council established seven institutional learning outcomes (RAIs), expected in all graduating students regardless of their major choice [18]. For each RAI, an assessment rubric was designed to standardize evaluation processes. One of these considers a student's "ability to function on multidisciplinary teams", and includes components that measure contribution towards a specific goal, effective communication within the team, and respect of opinions between team members. Each criterion presents four levels, ranging from Initial to Excellent (Fig. 3).

For the evaluation of this learning outcome, we considered three different criteria, in accordance with institutional goals: (1) Consider the roles of different members, (2) Discriminates relevant time for his/her contribution to the team and (3) Value teammates skills related to the team goal.

The criteria used in #1 and #3 considered a final peer evaluation survey, in which students evaluated the roles of each of their peer within the group. Students were asked if their teammates' skills had developed and if each student had demonstrated respect along the project. This peer evaluation had comprised: (i) the level of contribution along the teamwork, (ii) achievements of goals set in advanced, (iii) active participation in working group sessions, (iv) search of external help to resolve conflicts and (v) level of respect of opposing views. This peer evaluation was given at the end of the course. Criteria #2, was tested through teachers' supervision during a teamwork activity related to their projects in the classroom. The activity chosen for this evaluation criterion was the "ideation phase". During the session, team groups used the "importance-difficulty matrix", where students selected the potential ideas for alternative solutions. The most promising and feasible ideas were selected, with the possibility of generating a greater positive impact.

**RAI # 6: D) Ability to work as part of multidisciplinary team.**

Performance Criteria	Learning level			
	Initial	Developing	Developed	Excellent
1. Considers the roles of all team members.	Does not recognize his or her own role, nor his or her peers.	The student recognizes some but not all role, nor their interaction.	Recognizes all roles to achieve team goals and intentions.	The student recognizes the roles of all the members, knows how they interact and gets them to achieve their goals
2. Discriminates the relevant moment for his or her contribution in the team.	Does not contribute at all, or only contributes while interrupting other.	Contributions are limited, or have no impact on the team. In most cases he or she does not allow others to contribute.	Although the student does contribute, he or she does not encourage discussions or contributions of peers.	His or her contributions are always timely, encourages participation of peers.
3. Values the abilities of companions related to team goals.	His or her opinion is the only valid one. Does not respect, identify or value the criteria and skills of others or does not allow them to participate.	The student does not identify all the skills of his or her peers for the benefit of the group. The student does not always value all the skills of their peers.	Identifies the skills of peers, respects them always and fosters synergy.	The student identifies the skills of its peers, respects them and fosters synergy. Tries to develop his or her own skills, as well as others.

Fig. 3 Rubric RAI 6 from ESPOL

#### IV. RESULTS AND DISCUSSION

##### A. Problem definition and prototype proposals for solution

###### Case 1: Customer's experience of the Bonaterra Fair

The groups were formed in a multidisciplinary manner. Our first group was composed by six students in the following majors: Mass Communication, Audiovisual Production,

Oceanic Engineering, Agricultural and Biological Engineering, Chemical Engineering and Graphic Design and Advertising.

In this case, the group team conducted secondary research by looking for similar fairs in order to learn from other experiences. Later on, students attended the fair several times with the purpose of gather information through interviews with customers, while doing observations to discover unmet needs related to the experience at Bonaterra Fair. After the systematization of the information was collected, students applied a customer's journey map and empathy map, in which pain points, difficulties and constraints were identified.

The most relevant insights generated by the tool implemented were those related to communication strategy in relation to prices and product information, which were not the most appropriate since customers had to wait long to request information. Many of them decided to go to other stands and others did not buy any product after having waited for a long time. The team group observed this during their visits. Considering the relevant insight, a Point of View was designed during group meeting, reformulating the problem from "how to improve the customer's experience of the Bonaterra Fair" to "customers need to receive more information about the elaboration and prices offered at Bonaterra Fair". The phase problem definition phase allowed the generation of design principles, consisting of the requirements that the solution must have in accordance with Bonaterra Fair.

Later, the ideation phase was developed by applying different techniques to have as many as ideas as possible, but the most feasible option was to improve the strategy of the visual communication related to farmers' products. In parallel, different prototyping techniques have been taught along APS course and having some students from Social Communication and Audiovisual Production in the group, infographics and brand development prototypes were produced in order to validate them with the customers. The validation phase with customer at Bonaterra Fair gave students positive evaluation to the group, having products prices in sight, therefore farmers were not distracted by consulting product prices and were able to serve more customers (Table I).

TABLE I  
DESIGN THINKING PHASES AND TOOLS APPLIED: CASE 1

Phases	Tools
Research	Secondary research in Trade Fairs around the world. Agro-ecological Fairs.
Empathy	Primary research (interviews and observations) to Agro-ecological farmers' organization involved in Bonaterra Fair. Customer's Journey Map Customer's Empathy Map

Definition	<p>Insights:</p> <ul style="list-style-type: none"> <li>✓ Farmers are proud of their products and know that customers are concerned about their food consumption habits.</li> <li>✓ Fair customers need to receive more information about the elaboration and prices offered at Bonaterra Fair</li> </ul> <p>Point of View:</p> <ul style="list-style-type: none"> <li>✓ Fair customers need a better way to receive information about crop products and processes.</li> </ul> <p>Customer user profile: male client, married, 30 to 35 years old, with 3 children. He and his family usually live near Bonaterra Fair and prefer to consume organic products. He is aware of the importance of environmental care.</p> <p>Design Principles</p> <p>Economical and environmentally friendly. Easy to assemble and disassemble. Materials must be reusable.</p>
Ideation	Brainwriting, SIT, Importance – Difficulty matrix, IPOS Visual communication paths should be implemented to provide information related to farmers' products.
Prototype	Infographics and product brand development Stand re-organization
Validation	<p>After testing the prototype by conducting the assembly at the fair, students obtained the following feedback:</p> <ul style="list-style-type: none"> <li>✓ Customers had product prices in sight.</li> <li>✓ Farmers were not distracted by consulting product prices.</li> <li>✓ Customers had greater knowledge of the products.</li> <li>✓ Farmers had more time to serve customers.</li> <li>✓ Customers were able to take products directly from the stands to purchase.</li> </ul>

### Case 2. How to increase the flow of customers at Bonaterra Fair?

In our second group, we had students from the following fields of study: Tourism, Telematics Engineering, Chemical Engineering, Aquaculture Engineering and Petroleum Engineering.

For this case, the group had worked with the same client but the approach consisted of finding an alternative way to increase customers flow in Bonaterra Fair. This team had focused from the beginning on how Trade Fairs function around the world, in order to understand better how the advertising management and the interaction between fairs like Bonaterra and the community could work. Despite collecting information through interviews to customers *in situ*, the relevant insights were gathered through the monitoring of the social networks of Bonaterra and its interaction with people. There was brief information but not in relation to what the fair usually offers. Therefore, the problem definition evolved from “*how to increase the flow of customers at Bonaterra Fair?*” to “*fair customers need a better way to receive information about the fair location and activities developed at Bonaterra Fair*”.

Later, the ideation phase was developed to get alternative solution through the application of different tools for idea generation. According to the design principles, the solution proposed during group meetings and workshops sessions included the design of promotional posters with fair's activities for its distribution through social networks. The prototype consisted of a fan page which had generated interest evidenced through the 49 interactions and 52 likes achieved only after

days during the validation phase. The fan page had interactive videos of visitors at the fair and articles related to the benefits of the organic consumption (Table II).

TABLE II  
DESIGN THINKING PHASES AND TOOLS APPLIED: CASE 2

Phases	Tools
Research	Secondary research in Trade Fairs around the world. Search advertising management of Bonaterra Fairs. Interaction between community and social networks.
Empathy	Primary research (interviews and observations) to Agro-ecological farmers' organization that were in Bonaterra Fair. Customer's, agricultures' and fair visitors' Journey Map Customer's, agricultures' and fair visitors' Empathy Map
Definition	<p>Insights:</p> <ul style="list-style-type: none"> <li>✓ There is no description of the fair location for future customers.</li> <li>✓ Fair customers need to receive more information about the activities developed at Bonaterra Fair</li> </ul> <p>Point of View:</p> <ul style="list-style-type: none"> <li>✓ Fair customers need a better way to receive information about the fair location and information related to the activities developed at Bonaterra Fair.</li> </ul> <p>Customer user profile: Female client, 23 years old, undergraduate student. She lives near Bonaterra Fair and prefer to consume organic products.</p> <p>Design Principals Economical Interactive with social network</p>
Ideation	Brain writing, SIT, Importance – Difficulty matrix, IPOS Develop promotional posters related to Bonaterra Fair and spread in social networks by adding fair's activities and the site's sketch for geographic location.
Prototype	Elaboration of a Fan Page in social networks.
Validation	After publishing the Fan Page, the statistics revealed 57 likes and 49 interactions with users in two days. The interactions most welcomed by users involved informative videos and articles about the benefits, also organic products and images of people buying, interacting and enjoying their free time at the fair.

### Case 3: How to increase the number of donations for children in the Hogar Inés Chambers?

Our third group was formed by members of the following careers: Information Systems Engineering, Electrical Engineering, Economics and Graphic Design and Advertising.

In this case, the group had to work with Hogar Inés Chambers with the purpose of looking for alternatives to increase the number of donations for their children. The group started by searching different NGOs around the world to learn from other experiences on how non-profit organizations get donations.

Later, the group visited the institution to interview the president of the organization and other actors, although it was a weakness of the group not to have empathized with other stakeholders. Since the team tried to understand how donations are collected at Ines Chambers, they discovered that some donors contribute with products that not always are required by children. Thus, the problem reformulated, in the form of Point of View stated that Hogar Inés Chambers needed to engage more donors which could contribute with products that correspond to children's needs. In the ideation phase, the team

group emphasized the human side by making donors feel part of the organization. The idea selected was to provide and maintain an active interaction with donors through an app and crowdfunding web site. As the group was made up with student from information system engineering and graphic design, they developed a landing page for the NGOs' web site, with different tools that allowed them to validate if donors had improved their experience. The app demonstrated a way to donate by showing the products which are needed by children. In addition, there was a space where donor's activities were organized to form a donor community in the NGO (Table III).

TABLE III  
DESIGN THINKING PHASES AND TOOLS APPLIED: CASE 3

Phases	Tools
Research	Hogar Inés Chamber's representatives, Main donor company.
Empathy	Primary research (interviews and observations) at Hogar Inés Chambers. Actors mapping Customer's Empathy Map
Definition	Insights: <ul style="list-style-type: none"> <li>✓ Few donors contribute with products, which do not always correspond to their needs.</li> </ul> Point of View: <ul style="list-style-type: none"> <li>✓ Hogar Inés Chambers needs to retain and attract more donors because only few donors who contribute with products, which do not always correspond to their needs.</li> </ul> Customer user profile: A male investor in search of social projects, uncertain on which organization to donate to.  Design Principles Technological Links with companies
Ideation	Brainwriting, Importance – Difficulty matrix, Top-five <ul style="list-style-type: none"> <li>✓ Provide and maintain an active interaction with donors through an app and crowdfunding web site.</li> <li>✓ Demonstrate that organization needs are its core.</li> <li>✓ Make donors feel part of the organization.</li> </ul>
Prototype	Mock-up Landing Page
Validation	Interview with company donors and prototype testing

*B. Assessment students' outcome: Ability to function on multidisciplinary teams*

The following matrix and chart summarizes the evaluation results using the institutional rubric (fig. 4 and 5):

Students' careers	Test: Peer evaluation				Test: Facilitator supervision during teamwork				Test: Peer evaluation			
	Criteria 1				Criteria 2				Criteria 3			
	I	II	III	IV	I	II	III	IV	I	II	III	IV
Social Communication			1				1				1	
Audiovisual Production		1				1					1	
Oceanic Eng.				1				1			1	
Agricultural and Biological Eng.		1				1					1	
Chemical engineering				1				1				1
Graphic and Advertising Design				1				1				1
Tourism			1					1				1
Telematics Eng.		1				1						1
Chemical Eng.			1					1				1
Aquaculture Eng.		1						1				1
Petroleum Eng.			1				1					1
Systemes Eng.			1					1				1
Graphic and Advertising Design				1				1				1
Electrical Eng.				1				1				1
Economics			1					1				1
Electrical Eng.				1				1				1
Economics				1				1				1
Total	0%	29%	41%	29%	0%	29%	41%	29%	0%	41%	53%	6%

Fig. 4 Learning outcome evaluation of APS students. I Initial; II Developing; III Developed; IV Excellence.

For the criteria: consider the roles of different members, students' results located in "Developed" and "Excellence" levels reached 71.4%, while only 28.6% obtained a "Developing" level. Similar results were found in the criteria: discriminates relevant time for his contribution, reaching 71.3% in both "Developed" and "Excellence" levels. Finally, for the criteria: value teammates skills linked to the team goal, 72% attained "Developed" and "Excellence" levels. Although students achieved the proposed goal of 70%, the difficulty of working in multidisciplinary teams was evident mainly for two reasons: (i) different major resulted in conflicting schedules, making it difficult for students to coordinate time for group work, and (ii) free-rider problems, apparent in the final peer evaluation survey.

The evaluation of this learning outcome was made with three cases studies described above. This was a rapid assessment in order to identify if Design Thinking methodology applied in APS courses contributed to the development of different skills, which in this approach was narrowed to the ability to work in multidisciplinary teams for problem solving. Even though this study did not include a large sample size, it contributed to the generation of evidences for later work regarding academia and its impact in real case studies. This course is already part of every curriculum for all careers at ESPOL. Nevertheless, according to this study, it is necessary to improve the dynamic of group work by using more tools that could demonstrated the contribution of every member of the groups for projects in each semester.

We would like to thank Benemérita Sociedad Protectora de la Infancia, Hogar Inés Chambers and Feria Bonaterra for the significant collaboration in student projects. We also want to thank APS students that were part of this study, for their motivations and its persistence in the proposal of solutions. Our thanks to Entrepreneurs Center of ESPOL (CEEMP), for their trust and support in this work.

## REFERENCES

- [1] M. Vianna, Y. Vianna, I. K. Adler, B. Lucena, and B. Russo, *Design thinking. Business innovation*, 1st electr. Rio de Janeiro: MJV PRESS, 2012.
- [2] T. Brown, "Desing Thinking," *Harvard Businnes Review*, p. 9, 2008.
- [3] K. S. Retna, "Thinking about 'design thinking': a study of teacher experiences," *Asia Pacific J. Educ.*, vol. 8791, no. April, pp. 1–15, 2015.
- [4] Stanford University, "Research on Design Thinking." [Online]. Available: [https://dschool-old.stanford.edu/groups/k12/wiki/821fc/Research\\_on\\_Design\\_Thinking.html](https://dschool-old.stanford.edu/groups/k12/wiki/821fc/Research_on_Design_Thinking.html).
- [5] Consejo de Educación Superior (CES), "Reglamento Régimen Académico." República del Ecuador, 2013.
- [6] A. Arias Daniel, *Situación de la Transparencia y Rendición de Cuentas en las Organizaciones No Gubernamentales del Ecuador*. Quito, Ecuador, 2011.
- [7] N. Cross, *Design Thinking: Understanding How Designers Think and Work*. Bloomsbury Academic, 2011.
- [8] U. Johansson and J. Woodilla, "How to avoid throwing the baby out with the bath water : An ironic perspective on design thinking," in *Design*, 2010, pp. 1–25.
- [9] T. Lockwood, *Design Thinking: Integrating Innovation, Customer Experience, and Brand Value*. 2009.
- [10] B. Simpson and et al., "Title of paper goes here if known." .
- [11] R. F. Dam and T. Y. Siang, "5 Stages in the Design Thinking Process," *Interaction Design Foundation*, 2017. [Online]. Available: <https://www.interaction-design.org/literature/article/5-stages-in-the-design-thinking-process>.
- [12] T. Brown, "Design Thinking," pp. 84–92, 2008.
- [13] Hasso-Platter-Institute, "HPI-Stanford Design Thinking Research Program." [Online]. Available: <https://hpi.de/en/dtrp/program/overview.html>.
- [14] Design Council, "Eleven lessons: managing design in eleven global brands. A Study of the Design Process," *Des. Counc.*, vol. 44, no. 0, pp. 1–144, 2005.
- [15] H. Plattner, "An introduction to design thinking: process guide," *Institute of Design at Stanford*, vol. 1, no. 1. pp. 1–11, 2010.
- [16] Fundacion In Terris, "Fundación In Terris." [Online]. Available: <http://www.fundacioninterris.org/>.
- [17] RSA Grupo, "RSA Fundación en el hogar Inés Chambers." [Online]. Available: <http://www.rsa.ec/rsa-fundacion-en-el-hogar-ines-chambers/>.
- [18] ESPOL, "Resultados de Aprendizajes Institucionales." [Online]. Available: <http://www.cise.espol.edu.ec/es/resultados-de-aprendizajes-institucionales-rai>.

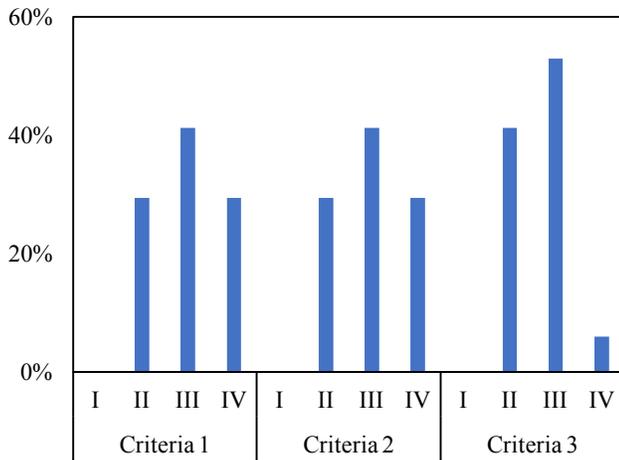


Fig. 5 Ability to work as part of multidisciplinary team: criteria 1,2,3 of APS students.

## V. CONCLUSIONS

This study shows how undergraduate students at ESPOL contribute to NGOs' problems, with the proposal of solutions in the Analysis and Problem-Solving course using Design Thinking. This was possible through the work of student teams composed by different disciplines. Each student contributed with a proposal for a solution, taking into account their expertise while focusing on human values and building empathy with the people they were designing for. Although projects finished with prototypes for the solutions proposed, the process could be difficult depending on the students' interests and motivations. There have been constraints in some teams during the process, since the ability to work as a part of a multidisciplinary team is being developed in collaborative learning processes that undergraduate students are not familiar with. Therefore, it is suggested to promote activities and collaborative learning environments using this Design Thinking methodology.

Analysis and Problem-Solving courses reach the prototype stage and its validation, considering users' needs, yet the implementation stage is not considered in this course, making it necessary to consider implementation plans and suggestions, so that students can provide them to the collaborating NGO. In other words, students can offer recommendations for implementing the prototype after the validation stage.

This course is very challenging, not only for students but also from a teacher's point of view. They must find problems in advanced with NGOs that are willing to work within this process of empathy, interacting with first year students and be able to accept proposal of solutions, not specifically tangible solution (implementation stage). However, the course represents an opportunity for NGOs to meet potential interns or future employees when students have shown a good performance.