Design Thinking: A New Perspective in the Academy-Community Relationship

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***Keywords*— Agricultural extension, design thinking, learning outcomes, participatory tools.**

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I. Introduction

Nowadays society demands a more efficient response to problems and challenges that humanity faces every day in socio-cultural and environmental terms at all scales [1]. According to this, the development of vulnerable groups is imperative through issues identification and solutions proposal that encourage the endogenous development of the society.

In this regard, Agricultural Extension (AE) represents an instrument for rural development focused on medium and small farmers and their families who subsist mainly on agriculture [2]. Meanwhile, the extension will be effective only if the scientific research focuses on the *farmer problems*, their *availability to land access and market*, with emphasis in social, economic and political security for a sustainable rural development [3].

Design Thinking (DT) is a creative approach based on the human-centered design that encourages multidisciplinary and collaborative perspectives for problem-solving [4]. The DT approach place people as the reason to be of the analysis and research innovative solutions [5], that means, identify human behaviour and needs to design prototypes and test them with support of different knowledge areas (psychology, sociology, engineering and marketing) reaching a holistic technical solution and socioeconomic feasible [6]. Since, DT is widely used in the field of architecture and engineering [7].

Other institutions like universities are adopting the conceptual appreciation of DT focused in the educational benefits for students [7], and on multidisciplinary projects for solving problems involving both the public and the private sector [8]. The prime examples of this are the REDlab at Stanford University that researches on DT in K-12, undergraduate and graduate settings [9], [10], and the Hasso-Platter-Institute that in collaboration with the Stanford University hold a Design Thinking Research Program with the aim "to apply rigorous academic methods to understand how and why Design Thinking innovation works and fails" [11].

Using the case of the Escuela Superior Politécnica del Litoral (ESPOL) that in agreement with the National Higher Education Council implemented courses with an analytical approach on problem-solving through the use of DT techniques. According to this, the Agricultural and Biological Engineering (ABE) program at ESPOL in order to bridge the gap between the future ABE professional and the farmer field experience, and thus contribute to strengthen the academia-community relationship offered the Introduction to the ABE and AE courses.

Despite that DT applicability in areas related to the agriculture has begun to be explored [12], there have been less studies focused to solve social problems linked to the agricultural environment. In Ecuador, the government is trying to adopt local strategies for AE through in-site talks made and set up by AE projects [13], but farmers are still difficult to get to and sometimes the AE models used are not conceptualized according to the producers point of view.

To address this issue, the present document aims to integrate the DT and the AE tools through the design of a prototype focused on problem solving by ABE students program together with the community members. Likewise, to stimulate the creativity in the students and their collaborative participation as a team connected with the everyday life of rural environment.

II. Methodology

The study area is located at the northwest part of the Guayas River basin, specifically at the Jigual village, belonging

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to the Juan Bautista Aguirre (JBA) parish of the Daule canton, Guayas province (Fig. 1). The 97 % of the JBA territory is covered by agricultural land, where rice is the most representative crop with the 60 % of the area, followed by the production of grass for cattle with 30 %, and a lesser extent mixed crops (mango, maize) given by family farming (2 %) and natural forest 5 % [14].

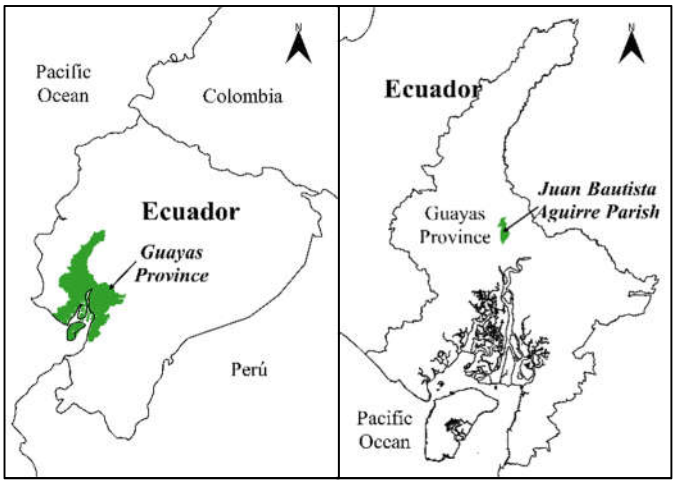

Fig. 1 Location of the parish Juan Bautista Aguirre with respect to Guayas province in Ecuador.

In JBA parish there are about 12 associations or rice-producing cooperatives, among these, the *Asociación comunitaria para la comercialización de productos agropecuarios Jigual* hereafter Jigual association, made up of 23 small-scale farmers with a production area between 0.5 to 2 ha [14], and the main source of income for its members is the rice production. It is an important highlight, that Jigual association members produce only during the dry season of the Ecuadorian coast (May – December) [15], attributable to this zone is exposed to floods in the rainy season [14].

On the other hand, the methodology was structured in two phases: The creative process and the Disciplinary Learning Outcomes (DLOs) evaluation.

A. Creative Process

The DT double diamond model was proposed by the Design Council structured on two diamond-shape map to describe the four phases (*discover, define, develop* and *deliver*) of a project life cycle [16].In the 2013, this model was modified by Dorman giving it more detail about how each diamond works for finding the right problem and finding the right solution [17]. Finally, in the 2016 Liu proposed an integration between the Dorman and the Stanford University's DT models obtaining effective solutions resulting in a double diamond DT model of five phases process: *empathize or discover, define, ideate, prototype* and *test* [18].

This document intends to apply a dynamic and creative methodology on problem-solving process in agricultural practices by the integration of double diamond DT five phases model [18] and the AE conceptualization [19], as described in Fig.3.

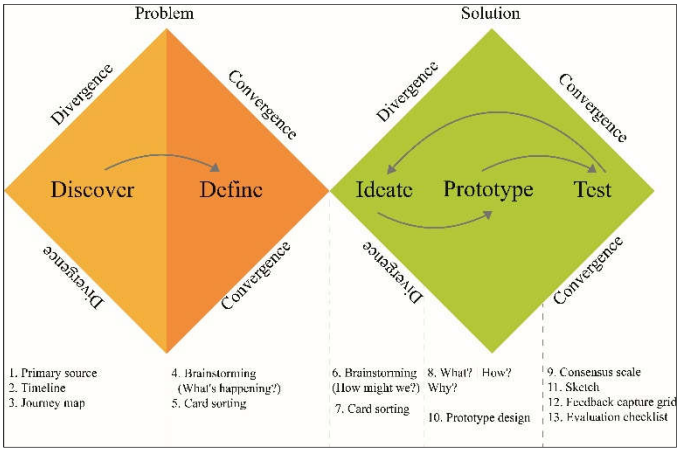

Fig. 2 Double diamond DT model [18], numbers indicate DT and AE tools applied throughout the creative process [21], [19].

Before the application of the methodology, a diagnostic workshop was conducted with members of the Jigual association using the *bottom-up* methodology [20], to identify difficulties in the rice production and commercialization processes. From this premise, three points of interest emerged from the farmers:

1) *Access to Irrigation Water*
2) *Plant Pests*
3) *Marketing Channels*

Later, students were asked to carry out a class project (prototype) by means of the collaborative learning approach given the advantages offered by this mechanism in the teaching-learning process [22], [23]. To do so, students were organized into work groups made up of three and four people, then each group selected one of the three identified problems.

The methodology also included the development of participatory workshops conducted both in classroom and in the field with the Jigual association members. The DT process and the implemented DT and AE tools are described below:

In the *discovery phase* the primary source and timeline tools of AE were applied [19], that thought the students to forge their own opinion about the problem, whereas with the journey map tool problems from the farmers' point of view were analysed [16]. To *redefine* the initial problem, students applied the brainstorming tool to understand What is really happening? and classify the priorities according to farmers by using the cart sorting tool for the final version of the problem [19], [21].

In the *ideate phase* students used the brainstorming tool to generate ideas and possible solutions through the question, how could we? and the card sorting tool to identify the most feasible ideas to solve the problem. Then, the identified ideas were socialized with farmers by means of the What? | How? | Why?

tool as *prototype* [21], to secondly make a model of the project (sketch).

The *testing phase* of the prototype idea was made using the consensus scale [19], to identify the degree of responsibility that the partners would accept in the improvement of production and commercialization processes. Then, the prototype sketch was analysed with the feedback capture grid [21], and evaluated using the check list [24]. In table I six indicators (approach and order, functionality, utility, applicability, user friendliness, and innovation) were described identified according to the association needs with three levels of compliance (comply, pending, do not comply).

TABLE I
EVALUATION CHECKLIST MATRIX

Indicators	Levels of compliance		
	Comply	Pending	Do not comply
Approach and order			
Functionality			
Utility			
Applicability			
User friendliness			
Innovation			

B. DLOs Evaluation

Career DLOs are based on the set of KNOWLEDGE, SKILLS, and ATTITUDES [15]. The evaluation of these is a fundamental part of the teaching-learning process, since it allows to detect points of strength and weakness aimed at improving this process [15], [25], [26]. Likewise, DLOs place the student in four different levels: initial, developing, developed and excellence for each criterion of performance [15], as it describes below:

1) DLO I: Ability to work as part of a team, according to the following criteria:

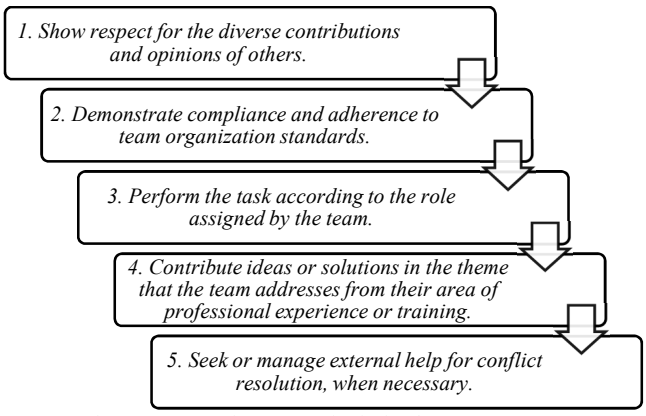

Fig. 3 Career performance criteria for the DLO I.

2) DLO II: Ability to apply skills, tools and techniques required in the agricultural engineering practice, according to the following performance criteria:

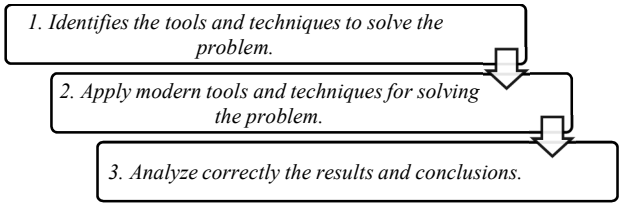

Fig. 4 Career performance criteria for the DLO II.

In regard to DLOs, these were evaluated in two different moments of the creative process: In the workshop with the association members (DLO I) and in the presentation of the physical sketch developed according to the solution approach (DLO II).

III. RESULTS AND DISCUSSIONS

A. Creative process

The results showed that the participation of the farmers in the workshops was fundamental in the proposal preparation process because it allowed the students to know where the problems were from the farmers' point of view [20]. It was therefore important to identify key informants as the decision makers and the most vulnerable smallholder farmers to agricultural risk, since the participation of all members of the association is a goal that is not always met.

1) Access to Irrigation Water: From the participatory workshop using the journey map tool, it was identified that the water source for irrigation is the Pula River, located approximately 3 km far away from the member's plots. This implies that the Jigual association have two water pumping stations, one to pump water from the Pula River to the Seco River and the other to bring the water from the Seco River to the irrigation canal built by the farmers on benefit of their plots. On the other hand, to access the service the association members established an irrigation schedule since the power of the pumps does not supply all agricultural plots at the same time. As well, it was identified that along the irrigation canal there are farmers whom are not part of the association but they use the service to irrigate their fields causing water flow reduction in economic detriment of the members of the Jigual association.

In addition, if the irrigation process represents a positive or negative experience to farmers was asked, to this, the farmers said that the irrigation process was a positive experience due to it allows them to obtain water for their crops. However, at the same time in the personal sphere had a negative impact because the canal maintenance represents an investment of time and money that sometimes conditions their life quality.

Subsequently this experience and the use of the What? | How? |Why? DT tool students proposed to the farmers, the idea of a pumping station with adequate characteristics of the system: (i) infrastructure for the storage and operation of the pump; (ii) irrigation channel improvement due to the constant maintenance by weeds growth, which represents an additional economic investment to the production costs; finally, (iii)

promote the association recruitment based on the member's benefits in terms of water distribution for the agricultural plots. With this proposal, farmers are expected to obtain a better organization in the management of the irrigation process for their agricultural plots.

Then, the idea was presented to farmers in a workshop by a sketch of the pumping system (Fig. 5), and with the feedback capture grid (Table II) the project obtained some constructive criticism for the design in terms of pump size and power requirement and irrigation scheduling.

TABLE II
FEEDBACK CAPTURE GRID FOR DESIGNING OF A STRUCTURE TO CONTAIN THE PUMPS[a]

Things one likes (+)	The proposal would be a significant project for the association.
Constructive criticism (Δ)	Control of canal flow of irrigation water. Analysis of pump needs to establish its capacity. Make an irrigation schedule.
Ideas ( )	Promote the association recruitment for farmers that use the irrigation service but are not register in the Jigual association Dredging of the Pula River.
Questions (?)	How prevent those farmers that not belong to the association use the irrigation service?

[a][21].

The sketch was evaluated by using the checklist tool (Table I), where the 87.5 % of the producers expressed that for the approach and order indicator, the proposal complies the objective to improve access to water resources, while 12.5 % indicated that the proposal must be improved, it mean that some details of the proposal is still pending. Likewise, the 100 % of farmers said that proposal complies according to the indicators: functionality, utility, applicability, user friendliness.

Fig. 5 Participatory workshop organized by ABE program students in collaboration with the members of the Jigual association, where a model prototype of the pumping station was presented.

2) Plant Pests: Pests is another factor that affects rice yields, mainly because of problems in terms of pests identification and control by the farmers [14]. The journey map tool reported that when farmers observe symptoms, they collect a sample and take it to an agrochemical company for its later identification and recommendations regarding the pesticide applications. However, this process does not guarantee the problem solution, since the samples are not subjected to a laboratory analysis or an expert valuation in the entomology or phytopathology area, as well as, the economic threshold is not determined for proceeding with chemical control.

Furthermore, farmers affirmed that pest's detection is a negative experience, while receiving help in pest's identification and control represents a positive experience due to the reduction of damage in their crops.

Under this background, and with the use of the What? | How? | Why? DT tool, it was proposed to train the farmers in the areas of entomology and phytopathology through an agriculture field school that include a demonstration plot (1 Ha), in this way farmers would be able to identify the biotic agents that affect the cultivation and to carry out an ecological pest management.

Later, by a sketch (Fig. 6) the students make known the proposal to the farmers and using the feedback capture grid (TABLE IIII) was reported that is a good initiative since it responds to their needs in pest control. However, farmers defined the interest in pest's identification and their subsequent phytosanitary control by answering the questions What? How? and When?

TABLE III
FEEDBACK CAPTURE GRID FOR THE AGRICULTURE FIELD SCHOOL PROPOSAL[a]

Things one likes **(+)**	This would be a good initiative for farmers. Predisposition to receive trainings in pests control topics.
Constructive criticism **(Δ)**	Pest prevention arguments.
Ideas ( )	Pest's identification at farmers' plots. Preparation of fertilizers based on organic products.
Questions (?)	Identification of pests. What? How? and When? apply phytosanitary measures.

[a] [21]

The proposal (sketch) evaluation was made by using the checklist matrix (Table I), in which the 100 % of the farmers said that the proposal complies to solve the problem for the indicators: approach and order, functionality, applicability, user friendliness, and innovation. While, for the utility indicator, the 36 % stated that the proposal is still pending, because in some cases they have received training by governmental organizations and these were not effective due to the absence of mechanisms to transmit the problems from the agricultural sector to researchers [27].

Fig. 6 Participatory workshop organized by ABE program students, in which they presented a sketch of the agriculture field school topics.

3) Marketing Channels: The marketing channels represent a limitation in the rice production chain [28]. Using the journey map technique two main causes that influence this process were detected:

The first is strictly related to the mobilization of the product from the farmer's fields to the rice milling plant for its subsequent transformation (paddy rice in white rice), since, the association does not have their own transport mean (truck) the farmers are subject to rent it. In this regard, the transportation service imposes the price influenced by the roads condition to reach the farmers' fields.

The second cause was the identification of a buyer, since there are not previous agreements for the marketing of rice, once processed. This lack of agreement makes farmers subject to sell rice to intermediaries who impose the price, being also a factor that influence the cost of production [28].

In this context, students by using What? | How? | Why? DT tool proposed and idea for creating a website, where farmers could market and sell their products, marking a start only with white rice. The idea is that a delegate of the association provides the information requested by the user when contacted and can complete the sale by phone, while, the payment would be at the time of delivery of the product. With the approach of marketing products through the use of technologies, farmers are expected to obtain a fair price for their product and in turn, and to provide a quality service to members of the community.

A model of a computer with the website detail (Fig. 7) was the way that students used to present the proposal sketch and with the use of the feedback capture grid (Table IV), the farmers made their observations on the project.

Regarding to the critical contributions, farmers highlighted the importance of detailing the legal constitution of the Jigual association and the information about the members of the steering committee. For the sketch improvement, the farmers proposed the sale of rice using different units of measure (pounds, arroba and quintals) and market both: the use in cooking recipes, and the sale of the rice derivatives used in livestock production.

Also, Table IV shows the farmers' concern about the determination of the sale price, because they do not control the costs of production, to this they requested a training in accounting, as well as, in the website management.

TABLE IV
FEEDBACK CAPTURE GRID FOR THE DEVELOPMENT OF A WEBSITE PROPOSAL[a]

Things one likes (+)	Marketing of the agricultural products.
Constructive criticism (Δ)	Highlight the legal constitution of the Jigual association. Detail the information of members of the steering committee.
Ideas (💡)	The marketing administration could be performed by a delegate of the association. Details of the process of crop production. Promotion the sale using different units of mass understanding buyers' need. Promotion the usefulness of rice with traditional recipes. Commercialization of rice husk and its derivatives. Create a rice brand with the name of the association "Arroz Don Jigual".
Questions (?)	Determine the selling price based on cost analysis. Training the partners on the management of the website. Internet connection access for the association, members wanted to be part of the marketing process.

[a][21]

According to the six indicators proposed for the check list evaluation (Table I) of the website, the farmers stated: functionality, utility, user friendliness and innovation, the sketch complies the 100 %. Regarding the indicator: Approach and order the 94 % of the members said that it complies, while 6 % indicated that this criterion is still pending. On the other hand, the partners considered that the applicability complies with 81.5 %, while 12.5 % said that it is pending and 6 % of farmers expressed that the proposal does not comply the needs identified in the association.

Fig. 7 Workshop organized by ABE program students in collaboration with the members of the Jigual association to illustrate the content of the website proposal.

B. DLOs Evaluation

The DLO I evaluation (Fig. 8) shows that the 11 students who attended the AE course, for the *criterion 1* are distributed in the *excellence* (55 %) and *developed* (45 %) levels. That means, students showed a good level of respect for the diverse contributions and opinions of others, however, for the students in *developed level* there is still a lack of balance in their interventions; The *criterion 2* shows that the 55 % of the students demonstrate an *excellent level* of compliance and adherence to team organization standards, the 36 % respect delivery times, meetings schedules, punctuality and other organizational aspects of the team, although students still need to be reminded (*developed level*). The other 9 % of the students reached the *developing level* due to organizational aspects of the team such as having to be reminded frequently about delivery times, dates of meetings, punctuality and so on.

The *criterion 3* recorded that the major part of students (64 %) perform the task according to the role assigned by the team *excellently* and the 36 % of them placed in *developed level* delivering incomplete tasks but allowing others members to advance on teamwork project responsibilities; On other hand, *criterion 4* reported that the major part of students (73 %) are in the *excellence level* since they contribute for ideas or solutions in the theme that the team addresses from their area of professional experience or training, in minor proportion the 18 % of students collaborate (*developed level*), while the 9 % in the *developing level* contribute with ideas or solutions, but, these contributions are not related to the project purpose. Finally, for the *criterion 5,* the 36 % of the students seek or manage external help for conflict resolution when necessary efficiently (*excellence level*) and the 64 % of them ask for help from teachers or others to resolve conflicts, although it is necessary to ask them to do it (*developed level).*

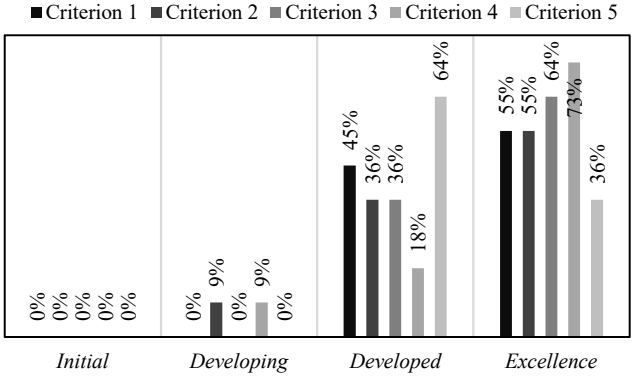

Fig. 8 DLO I evaluation.

The distribution in the *developing*, *developed* and *excellence* levels is mainly due to the fact that students are attending the 2nd, 3rd, 4th and 5th year of ABE program and the collaborative work in the first years of the course is not so effective in comparison with the students who attend the last years of the program in terms of strengthening of skills [22]. To meet this need, the ABE program has imposed prerequisites on the course, based on the request of the National Higher Education Council to carry out a curricular revision aligned to the needs of local and national development [29].

The DLO II (Fig. 9) evaluation shows that the 100 % of the students are able to identify tools and techniques processes oriented to problem-solving (*criteria 1*). While in *criteria 2* and *3* the results shown that in the major part of students (72.3 %) are at the *level of excellence* and 23.7 % at the *level of developed*. It means, students are able to apply modern tools and techniques for solving the problem and analyse correctly the results and conclusions. However, the students placed in the *developed level* still require constant guidance after the explanation.

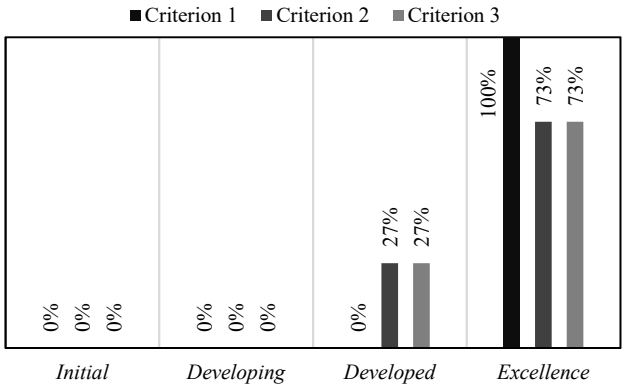

Fig. 9 DLO II evaluation.

The difference in the criteria 2 and 3 respect to 1 is due in particular to those students who worked on the access of irrigation water proposal, since they were attending the first semester of the second year and in this phase, they do not yet have the technical knowledge of irrigation and drainage systems course to determine the water requirements of the crops and the pumping station. However, thanks to the problem identification process, the construction of the proposal with farmers, and the use of DT and AE tools it was stimulated the students creativity capabilities, and the problem-based learning improved [30], [31].

IV. Conclusions

The integration of the DT and AE concepts helped the students made a proposal, regarding the farmers' needs along the production chain. In this regard, the Jigual Asociation was pleased with the initiative to collaborate with the students for projects proposals aimed to solve local problems.

Furthermore, the approach based on problem-solving techniques stimulated the students to develop their capacity to design, innovate and commit contributing to the knowledge society. It is important highlight too, that students understood that the mission of AE is not limited exclusively to the technology transfer, but also covers other perspectives of the professional challenge.

Regarding, to the DLOs evaluation were detected limitations in the teaching-learning process, to this was proposed adjustments in the curricular revision, academic-community engaged learning improvement and student research emphasis according to National Higher Education Council regulations and development society.

This type of work could be a point of reference for future research related to the methodologies to encourage the design for agricultural development, since there is not enough information on this topic. Also, DT and AE integration concepts could be applied to other areas of social development, as well as, be adopted by other local universities.

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REFERENCES

[1] Organización de las Naciones Unidas para la Educación, la Ciencia y la Cultura (UNESCO) and UNESCO, "Documento de Política para el Cambio y el Desarrollo en la Educación Superior," UNESCO, 1995.

[2] N. Calle, N. Vasconcellos, and M. Quilanbaqui, "Programa de Extensión Agrícola para la producción y manejo agronómico de cultivos en la comuna de San Rafael de la Provincia de Santa Elena." de Escuela Superior Politécnica del Litoral (ESPOL), 2011.

[3] FAO, "Cómo movilizar el potencial de la extensión agraria y rural." FAO, 2010.

[4] M. Vianna, Y. Vianna, I. K. Adler, B. Lucena, and B. Russo, *Design thinking. Business innovation*, 1st electr. Rio de Janeiro: MJV PRESS, 2012.

[5] E. Segarra, "¿ De dónde proceden las ideas ?: las fuentes de la innovación en la empresa," *Harvard Deusto Bus. Rev.*, vol. 1, pp. 50–56, 2010.

[6] S. O. Manuel and P. Blázquez C., "Design thinking: Lidera el presente. Crea el futuro." ESIC Editorial, España, p. 160, 2015.

[7] K. S. Retna, "Thinking about 'design thinking': a study of teacher experiences," *Asia Pacific J. Educ.*, vol. 8791, no. April, pp. 1–15, 2015.

[8] C. Wrigley and K. Straker, "Design Thinking pedagogy: the Educational Design Ladder," *Innov. Educ. Teach. Int.*, vol. 3297, no. October, pp. 1–12, 2015.

[9] Stanford University, "Research on Design Thinking." [Online]. Available: https://dschool-old.stanford.edu/groups/k12/wiki/821fc/Research_on_Design_Thinking.html.

[10] REDlab, "Research in Education & Design." [Online]. Available: http://web.stanford.edu/group/redlab/cgi-bin/publications_resources.php.

[11] Hasso-Platter-Institute, "HPI-Stanford Design Thinking Research Program." [Online]. Available: https://hpi.de/en/dtrp/program/overview.html.

[12] X. D. Li, W. P. Hu, and X. P. Yang, "Design thinking on urban agricultural construction of intelligent ecological residential building," *Appl. Mech. Mater.*, vol. 357–360, pp. 482–486, 2013.

[13] MAGAP, "Proyecto Nacional de Innovación Tecnológica Participativa y Productividad Agrícola (PITPPA)." [Online]. Available: http://www.agricultura.gob.ec/proyecto-nacional-de-innovacion-tecnologica-participativa-y-productividad-agricola-pitppa/.

[14] Homo Faber, Consultores, "Plan de Desarrollo y Ordenamiento Territorial GAD Juan Bautista Aguirre 2015-2019." .

[15] M. F. Calderón *et al.*, "Uso de los Sistemas de Información Geográfica (SIG) como herramienta de aprendizaje aplicado en el proceso de integración Universidad-Comunidad," in *Laccei proceedings: Engineering Innovations for Global Sustainability*, 2016.

[16] Design Council, "Eleven lessons: managing design in eleven global companies. Desk research report," *Engineering*, vol. 44, no. 272099, p. 18, 2007.

[17] D. Norman, *The Design of Everyday Things: Revised and Expanded Edition*. 2013.

[18] J. Liu, "Visualizing the 4 Essentials of Design Thinking – Good Design," Feb-2016. [Online]. Available: https://medium.com/good-design/visualizing-the-4-essentials-of-design-thinking-17fe5c191c22. [Accessed: 17-Jan-2017].

[19] F. Geilfus, *80 Herramientas para el desarrollo participativo: diagnóstico, planificación, monitoreo, evaluación*. C.R.: IICA, 2009.

[20] A. Santos, C. Párraga, M. Torres, J. Galarza, and F. Calderón, "Implementación de herramientas metodológicas para el fortalecimiento de las capacidades socio-económicas de los agricultores: el caso de la asociación 'Dios con nosotros,'" *Yura Relac. Int.*, vol. 10, pp. 115–125, 2017.

[21] Stanford D.school, "Bootcamp Bootleg," *Stanford D.school*. Hassno Platner & Institute of Design at Standford University, p. 47, 2010.

[22] F. G. Lillo Zuñiga, "Aprendizaje colaborativo en la formación universitaria de pregrado," *Rev. Psicol. - Univ. Viña del Mar*, vol. 2, no. 4, pp. 109–142, 2013.

[23] H.-Y. Sung and G.-J. Hwang, "A collaborative game-based learning approach to improving students' learning performa nce in science courses," *Comput. Educ.*, vol. 63, pp. 43–51, 2013.

[24] P. Richard and L. Elder, "La mini-guía para el pensamiento crítico conceptos y herramientas." Fundación para el pensamiento crítico, 2003.

[25] A. Villa, L. Campo, S. Arranz, O. Villa, and A. García, "Valoración del profesorado de magisterio sobre el aprendizaje basado en competencias implantado," *Profesorado*, 2013.

[26] A. Santos-Ordoñez, C. Párraga-Lema, J. Galarza-Villamar, and M. Torres-Naranjo, "La Extensión Universitaria al servicio de la comunidad rural: caso de la caja de ahorro 'Unidos somos más,'" 2016.

[27] FAO, *Políticas de desarrollo agrícola: Conceptos y principios*. 2004.

[28] AVSF - SIPAE, *Dinámicas de comercialización para la agricultura familiar campesina: desafíos y alternativas en el escenario ecuatoriano. Capitulo: Dinámicas de comercialización campesina en territorios*, Primera Edición. Quito, 2013.

[29] Consejo de Educación Superior (CES), "Reglamento Régimen Académico." República del Ecuador, 2013.

[30] J. Galarza Villamar, M. Torres Naranjo, C. Párraga Lema, and A. Santos Ordoñez, "Aplicación del método de aprendizaje basado en problemas: Estudio de caso del barrio Atucucho," in *Laccei proceedings: Engineering Innovations for Global Sustainability*, 2016.

[31] Laysa Mabel de Oliveira Fontes, Francisco Milton Mendes Neto, Fábio Abrantes Diniz, Danilo Gomes Carlos, Luiz Jácome Júnior, and Luiz Cláudio Nogueira da Silva, "Um agente pedagógico animado de apoio à aprendizagem baseada em problema," *IEEE-RITA*, vol. 7, pp. 181–188, 2012.