Design and efficacy of an Ecohealth competency-based course on the prevention and control of vector diseases in Latin America

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Abstract

Objective. To design and analyze the efficacy of an Ecohealth competency-based course on the prevention and control of vector-borne-diseases for specific stakeholders. **Materials and methods.** Multiple stakeholders and sectors of the region were consulted to identify Ecohealth group-specific competencies using an adjusted analysis matrix. Eight courses based on the competencies were implemented to train EA tutors. The effectiveness of the course was evaluated through the use of paired- t-tests by intervention group. **Results.** Strategic, tactical, academia and community stakeholder groups and their competencies were identified. An overall gain of 43 percentage points (p<0.001) was observed in terms of competencies score in trained tutors, which further trained 1 033 people. **Conclusion.** The identification of the stakeholders and their competencies proved to be useful to guide training courses to significantly improve the initial competencies and create a critical mass to further advance the EA in the region.

Keywords: competencies; vector borne diseases (VBDS); health training

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Resumen

Objetivo. Diseñar y analizar la eficacia de un curso basado en competencias de Eco-Salud para la prevención y control de enfermedades transmitidas por vectores, para actores específicos. **Material y métodos.** Se consultaron múltiples actores y sectores de la región para identificar las competencias específicas del enfoque de Ecosalud, que deberían de tener los grupos clave utilizando un análisis de matriz ajustado. Se implementaron cursos de capacitación utilizando las competencias para capacitar a tutores en el enfoque. La efectividad del curso se evaluó mediante el uso de pruebas t pareadas por grupo de intervención. **Resultados.** Se identificaron los grupos clave para la prevención y control de las ETVs: estratégico, táctico, académico y comunitario, así como sus competencias. Se capacitaron tutores y se obtuvo un incremento en relación con las competencias iniciales de 43 puntos porcentuales (p <0.001). **Conclusión.** La identificación de los grupos clave y sus competencias demostró ser útil en el diseño de un curso para incrementar el nivel inicial de competencias y crear una masa crítica para Ecosalud en la región.

Palabras clave: competencias; enfermedades transmitidas por vectores (ETV); capacitación en salud

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Around 500 million people in the Americas are at risk of dengue infection, the most important emergent vector borne disease (VBD) in the region.[1] Malaria is distributed in 21 countries in the region, where 145 million people are at risk. Chagas disease threatens around 65 million people and 6 to 8 million persons are infected in 19 countries in the region.[2,3] The region´s cumulative experience has incorporated community participation and behavioral changes (COMBI), along with integrated control strategies, replacing the hegemony of interventions based mainly on disease-vector control using insecticides. Under certain conditions, these approaches are highly successful, but these vertical programs are not sufficient because they are reactive rather than preventive.

The Ecohealth approach (EA)[4] has proven to be successful in VBDs prevention and control. It involves strategies integrating the analysis of social, economic, cultural and environmental determinants.[5] These are essential to understand the best prevention and control options with the incorporation of trans-disciplinary strategies, along with the participation of affected communities.

Several EA research projects have been successfully carried out in various countries of the American region,[6-8] which have contributed to the elimination of DDT for malaria control in Mexico and Central America,[9,10] a decrease in malaria transmission in Nicaragua and Honduras,[11] the impact on malaria vector infestations by changing flooding practices in rice crops in Peru;[12] and the control of dengue in Cali, Colombia.[13] A very successful intervention was conducted in Guatemala, Honduras and El Salvador,[14] based on wall plastering to abate indoor Chagas disease triatomine vectors. However, the incorporation of the EA is still very limited.

A partnership of four leading academic institutions in public health (the National Institute of Public Health in Mexico, the Center for Health Studies and Research, Foundation Santa Fe in Colombia, The Laboratory for Social Sciences in Venezuela and the Consortium for Health, Environment and Development in Peru), engaged in an initiative to advance the incorporation of EA for VBDs' control (EA-VBDs) in Latin America, since 2011. The core strategy of this initiative was the construction of a critical mass of diverse health professionals, technicians, community leaders, and other stakeholders in each participating country[4]

The main activity for the construction of transdisciplinary stakeholder groups was training tutors (professionals capable to train other stakeholders) in structured workshops. It was recognized that because of their composition and their roles in dealing with VBD prevention and control, stakeholder-specific competences were required, but these had not been identified and no training courses were available. We present herein the construction of EA training courses for tutors, based on the EA competencies that the diverse stakeholders require to successfully participate in the prevention and control of VBDs. The resulting tutor course was implemented in eight occasions and their efficacy in the acquisition of the desired competencies was tested.

Materials and methods

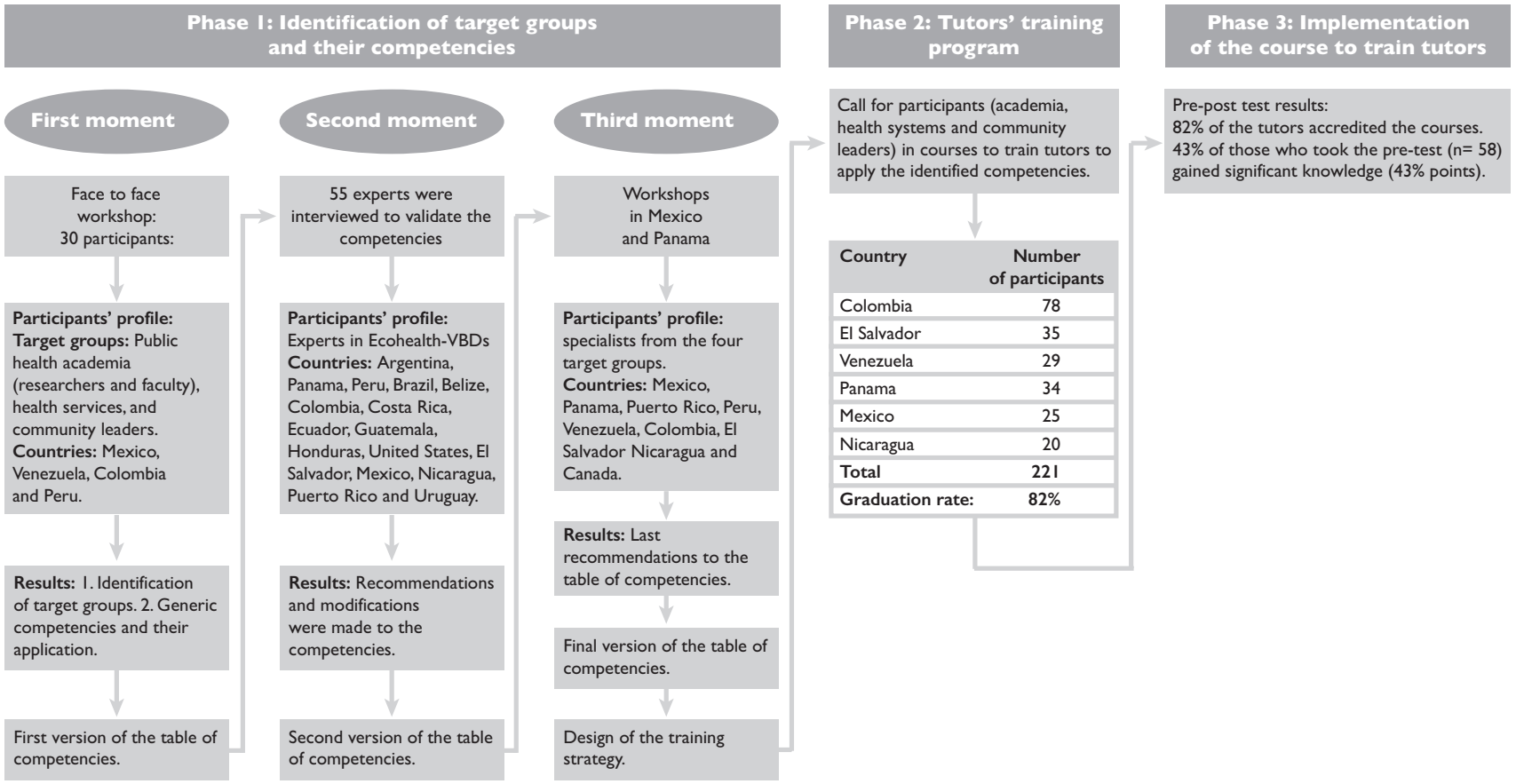
The study included three phases: *1)* the identification of target groups and their competencies, *2)* the construction of a training course for tutors to use the competencies to train the target groups, and *3)* implementation of the course to train tutors (figure 1).

To identify target groups and their specific competencies, consultations and discussion in two workshops were conducted (figure 1). Multiple stakeholders and sectors of the Americas and the Caribbean region were consulted (figure 1), and a workshop to identify target groups involved with VBDs' prevention and control and to identify the competencies for each group was carried out. To guarantee the inclusion of multi-sectorial and multidisciplinary perspectives, 30 participants from selected educational institutions, health ministries, community members and non-government organizations participated in a workshop. Participants included a mixture of professional profiles related to public health research, health services, and academia and community leaders, mostly involved with VBDs, but not necessarily had the same knowledge of the EA.

Participants divided into teams were asked to identify the target groups and subgroups using an adapted involvement/interest matrix[15] (figure 2), and to define the most important subgroups, according to the type and level of involvement with VBDs, regardless of their interest, and justify their classification.

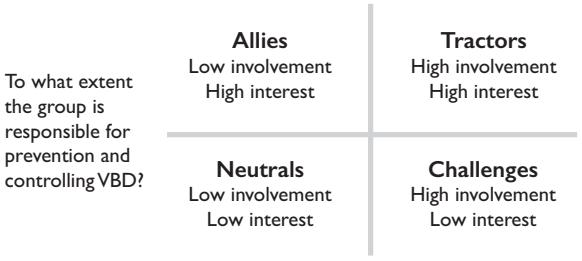
An occupational analysis approach[16] was used to identify which skills, knowledge and attitudes the decision-makers, operational-tactical personnel, community members and academics should have in order to investigate, teach, control and prevent VBDs with an EA. Responsibilities, labor context and products were used as descriptors, and activities and work dimensions provided the levels of the analysis.

Based on the Ecohealth principles,[4] the competencies were conceived as the dynamic interaction of a particular set of knowledge (knowing), skills (know how to do) and attitudes (know how to be) that make it possible to perform certain activities efficiently, effectively and with a high degree of ethical commitment.[17] Competencies for constructing informed and participatory communities were included for all groups. The Bloom



Country	Number of participants
Colombia	78
El Salvador	35
Venezuela	29
Panama	34
Mexico	25
Nicaragua	20
Total	**221**
Graduation rate:	**82%**

Figure 1. Flow chart of the study carried out in Colombia, El Salvador, Mexico, Nicaragua, Panama and Venezuela 2012-2015



VBD: vector borne disease

Figure 2. Matrix of attributes used to select target groups for the study carried out in carried out in Colombia, El Salvador, Mexico, Nicaragua, Panama and Venezuela 2012-2015

Taxonomic Levels were used as a guide to ensure that the competencies were written properly and arranged in different taxonomic levels.[18]

In a second instance, competencies were validated at the University of Puerto Rico in collaboration with Nova Southeastern University in Florida, and 55 professionals affiliated with public, academic and community sectors, from Argentina, Panama, Peru, Brazil, Belize, Colombia, Costa Rica, Ecuador, Guatemala, Honduras, United States, El Salvador, Mexico, Nicaragua, Puerto Rico and Uruguay were consulted (these professionals were different from those participating in the identification of competencies). These experts, representing the four identified target groups, received, via e-mail, a reference document providing an explanation of the components and pillars of the EA,[4] and a questionnaire asking to evaluate the competencies identified for each target group and determine if other target groups should be considered.

To revise the last version of the competencies, a second workshop was conducted with 50 specialists in public health research, education, and health personnel, from 12 countries in the region. The workshop was divided into two groups, one in Mexico and the other one in Panama. They worked in a mirror fashion (the same tasks at the same time). Four teams (one for each target group) were formed at each site to deeply characterize target groups. The groups revised the adjusted competencies and the adjusted involvement/interest matrix again to validate them and shared recommendations for their training, according to their interest and involvement. Each group also discussed an open question questionnaire dealing with aspects related to the stakeholders' general characteristics, access and capacity for managing information technology and autonomy for learning, as well as previous experiences, obstacles and motivators. The products generated in both venues were shared through video-conferencing, revealing great similarities between them.

Construction of a training course for tutors. With the final version of the competencies (table I) a training strategy was developed focusing on preparing tutors that would carry out the training of target groups, using the identified competencies. The tutors' course objective was to give the participants the theoretical, methodological and practical tools to conduct courses and workshops using the table of competencies. The tutors' course was replicated eight times in Colombia (Cali and Bogotá), El Salvador, Venezuela, Panama, Mexico and Nicaragua. The content of the course was: (I) background; (II) the pillars of the EA; (III) legislation and Ecohealth and (IV) teaching Ecohealth: Basics (table II).

Implementation of the EA course to train tutors. The course was carried out in a blended format in three phases: (1) face-to-face (30 hours) (2) online (20 hours), and (3) an implementation project, where participants had up to three months to develop and implement a project to train a specific target group using the competencies map. The report of these activities was part of the course evaluation and accreditation. The training based on competencies integrated an applied holistic learning to potentiate transformational knowledge;[19,20] from the workplace to the cognitive aspect, to promote the development of skills, linking knowledge, attitudes and values, to provide a comprehensive education.[21] This approach is based on the five pillars proposed by the UNESCO: learning to know, learning to do, learning to live together, learning to be and learning to transform oneself and society.[17]

Course efficacy evaluation. A voluntary pre-test was conducted to the participants to measure their knowledge level of EA, and a final test was implemented to measure the advancement of the knowledge related to identify the principles and applications of the EA. Both, pre-test and final test were questions and answers that measured the level of knowledge of EA, and were expressed as a 0-10% grade. After verifying the normal distribution assumption of the pre-final changes by means of a skewness-kurtosis test, we applied a Student's paired T-test to the data to ascertain whether the average change in knowledge was significant, stratifying by target group. The independence assumption was taken as granted due to the study design and the stratified nature of the analyses. All analyses were performed in Stata version

Table I

Competencies for each target group identified in carried out in Colombia, El Salvador, Mexico, Nicaragua, Panama and Venezuela 2012-2015

Target Group 1: Strategic group
Description: Managers and executives at various levels of government, legislators, businesspersons, leaders of funding agencies, and private functions.
1. Explain the components of an Ecohealth approach and the benefits of VBDs prevention and control.
2. Communicate the effectiveness of an Ecohealth approach in managing VBDs.
3. Identify areas of opportunity to coordinate actions for managing VBDs using an Ecohealth approach.
4. Identify VBDs risk transmission factors.
5. Generate actions that will promote public policies and financing of initiatives with the ecosystem approach.
Target Group 2: Tactical/Operational
Description: Leaders and Program Managers involved with Ecohealth and VBDs.
1. Explain the components of an Ecohealth approach and the benefits it provides in managing VBDs.
2. Communicate the effectiveness of an Ecohealth approach in managing VBDs.
3. Effective collaboration with inter-disciplinary stakeholders to implement VBDs control programs using an Ecohealth approach.
4. Identify areas of opportunity to incorporate actions for managing VBDs using an Ecohealth approach.
5. Identify, in cooperation with other stakeholders, VBDs risk transmission factors.
6. Implement programs for VBDs control using an Ecohealth approach.
7. Evaluate the impact of an Ecohealth approach for ongoing improvement.
8. Incorporate scaling-up strategies into Ecohealth programs for the prevention and control of VBDs.
Target Group 3: Community
Description: Community Leaders and Community Members
1. Explain the components of an Ecohealth approach and the benefits of VBDs control and prevention.
2. Communicate the effectiveness of an Ecohealth approach in managing VBDs.
3. Identify the advantages and benefits of an Ecohealth approach for the prevention and control of VBDs.
4. Disseminate, according to every context and to the different actors, an Ecohealth approach.
5. Participate in the design, implementation, and evaluation of actions for the prevention of VBDs with an Ecohealth approach.
6. Identify VBDs risk transmission factors in its surroundings and sociocultural, biological, and ecological conditions.
7. Promote organization and social action for the implementation of an Ecohealth approach in VBDs.
Target Group 4: Academia
Description: Undergraduate and Graduate (students and teachers)
Students/Teachers (shared)
1. Explain the components of an Ecohealth approach and the benefits it provides managing VBDs.
2. Communicate the effectiveness of an Ecohealth approach in the management of VBDs.
3. Analyze the social and environmental determinants of VBDs.
4. Identify, in cooperation with other stakeholders, VBDs risk transmission factors.
5. Analyze the concepts and theories of VBDs (entomology, identification of the vector, vector control, diseases, prevention and control, epidemiology) with an Ecohealth approach.
Teachers (exclusive for teachers)
a) Incorporate an Ecohealth approach into curriculum and training courses.
b) Develop research projects for the control of VBDs with an Ecohealth approach.
c) Use collaborative strategies for the organization and social action in the implementation of projects and programs of VBDs control with an Ecohealth approach.
d) Evaluate interventions with an Ecohealth approach and compare it with other interventions for scaling-up.
Students (exclusive for students)
a) Incorporate into the professional practice the participation of the community members and the different social actors involved with VBDs.
b) Develop participatory research projects for VBDs prevention and control with an Ecohealth approach that generates scientific evidence for public policies.
c) Work in collaboration with other stakeholders in the organization and social action for the implementation of VBDs control programs with an Ecohealth approach.
d) Incorporate scaling-up strategies in research projects - participatory action and in Ecohealth programs for the control of VBDs.

VBD: vector borne disease

Table II
Tutors' course content by module used in the study carried out in Colombia, El Salvador, Mexico, Nicaragua, Panama and Venezuela 2012-2015

Module	*Competencies*	*Content*
1. Background	1. Describe the theoretical foundations of the Ecohealth approach and the benefits it provides for the proper management of vector-borne diseases.	1.1 Origin of the Ecohealth approach. 1.2 Ecohealth as an alternative to previous conceptions of the relationship between health and environment; disruptions with these concepts. 1.3 Theory of systems and complex systems. 1.4 Ecosystems and socio-ecosystems. 1.5 Ecology and cycles of VBDs (dengue, malaria and Chagas).
2. The pillars of the Ecohealth approach	1. Design VBDs studies and programs according to the principles of the Ecohealth approach, including trnasdisciplinary approaches (social, environmental and health sciences, and popular knowledge), social gender and equity and social participation.	2.1 Transdiscipline. 2.2 Social participation. 2.3 Social equity and gender. 2.4 Sustainability and VBDs programs. 2.5 Translation of knowledge.
3. Legislation and Ecohealth	1. Analyze the factors that limit or favor scaling VBDs programs based on the Ecohealth approach to redesign or redirect them in order to promote their implementation. 2. Analyze current policy frameworks of VBDs programs and their linkage with the Ecohealth approach to identify scaling opportunities.	3.1 Analysis of policy frameworks and Ecohealth in eight different countries. 3.2 Scaling of the Ecohealth approach (analysis of barriers for scaling up).
4. Teaching Ecohealth: pedagogical foundations	1. Develop teaching skills to train different target groups in the Ecohealth approach.	4.1 Principles of constructivism and meaningful learning. 4.2 Active learning strategies. 4.3 Ecohealth teaching models and their application for different target groups.

VBD: vector borne disease

13 (StataCorp, College Station, TX) and considered estimates with a p-value of less than 0.05 as being statistically significant (table III). An additional pedagogical tool was used to carry out a practical exercise about the pillars of Ecohealth. This was a Game-learning based on cases with different paths depending on decision making. This resource was used to evaluate the level of comprehension of the participants. Also, at the end of the course, a satisfaction questionnaire was answered by all the participants in order to know the facilitating and limiting factors for completing the course.

Results

The following strategic target groups were identified:

1. Strategic group: decision makers, financiers, and health government officials responsible for developing public policy and allocating budgets for programs. This group is responsible of supporting and encouraging the design, implementation, validation and scaling up effective and sustainable strategies for the surveillance, prevention, control and elimination of VBDs.
2. Operational-tactical personnel: professionals that belong to the health system, mostly responsible for VBDs' programs who apply prevention and control and elimination measures.
3. Communities and civil social organizations: people in the community and community leaders that actively participate in the understanding, prevention management, control and elimination of VBDs in collaboration with the control program and cross-sector actors.
4. Academic group: postgraduate students, researchers and university teachers. This target group is fundamental for institutionalizing academic programs for VBDs under the AE and developing sustainable, scalable and convincing public policy scientific practices for the comprehensive study of VBDs' control and elimination.

Three content areas were identified: VBDs, Ecohealth, and scaling up; five general domains were defined: *1)* communication, *2)* coordination, *3)* design of actions and programs, *4)* implementation of actions and programs and *5)* evaluation of actions and programs. Six generic, cross-competencies were developed for all target groups and the description of the application level according to each target group (table IV). This table was very useful to identify the specific competencies for each group.

Table III
Results of the analysis of the pre and post tests to estimate the knowledge of the participants in the courses in the study carried out in Colombia, El Salvador, Mexico, Nicaragua, Panama and Venezuela 2012-2015

		Baseline			*Final*			*Difference*			
Group	*n*	*mean*	*95%CI*		*mean*	*95%CI*		*mean*	*95%CI*		*p-value*
Mexico (Merida)	16	26.04	9.52	42.57	84.33	73.65	95.01	-58.29	-76.35	-40.23	<0.001
Colombia (SENA)	3	33.33	-38.38	105.04	100.00	100.00	100.00	-66.67	-138.38	5.04	0.060
Central America (Managua)	15	35.56	21.66	49.45	78.90	66.36	91.44	-43.34	-65.28	-21.41	0.001
Colombia (Bogota)	24	45.14	29.40	60.87	76.27	67.77	84.77	-31.13	-50.03	-12.24	0.002

Consultation with experts achieved consensus in the assigning of competencies for each target group. The final version of the competencies is presented in table I. For each target group three cross-cutting themes were defined: *1*) the theoretical and practical aspects of VBDs (epidemiology, entomology and risk determinants), *2)* components and principles of the EA, (systemic approach, trans-disciplinary, social participation, environmental sustainability, social and gender equity and community participation), and *3*) a scaling up perspective (table IV).

Four generic competencies were identified, across all target groups: incorporate the EA in VBDs prevention and control; communicate the effectiveness of EA in the management of VBDs; identify opportunities to coordinate actions for VBD management; and identify risk transmission factors of VBDs.

Other competencies were more specific to each target groups, for instance, competencies for the strategic group provided elements for leading control programs with strategies for scaling up and influencing policy. For the operational tactical group, elements for control and preventive operations, and the procurement of social participation were included. For communities, competencies would enable them to understand conditions for VBDs' transmission, their relationship with the environment and the benefits of actively participating in their prevention and control. Researchers in the academic group require competencies to conduct EA-based research and the skills to collaborate with affected communities and related stakeholders, and to generate inputs for the design of control strategies. Students trained under an Ecohealth oriented program could understand the benefits of the EA in VBDs' surveillance, prevention and control.

The table of competencies considered three levels: *1*) knowledge (what each target group must know), *2*) skills (what each target group must be able to do) and *3*) attitudes (principles, values and ethical standards that should be encouraged in the target groups).

Although all target groups must be able to explain the components of the EA and their advantages, the perspective and in depth of knowledge vary. Thus, the pillars and principles of the EA were prescribed to all target groups, but the depth and variety of contents gave greater importance to some principles over others, depending on the group. For example, greater emphasis on the aspects of promotion and organizational activities for communities was proposed for VBD control program groups.

Training participants to be tutors

A total of 221 participants from ten countries: Colombia, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, Mexico, Panama, Venezuela and Peru, participated in the courses. In the implementation stage of the training, the participants in order to develop competencies to be tutors they have to replicate the course with a selected target group, a total of 1 033 people from all target groups were trained by the tutors: 41 decision-makers in three courses, 247 tactical-operative personnel in 10 courses, 474 academics, researchers and teachers in 13 courses, and 271 community representatives in seven courses.

Evaluation of the courses. Eighty-two percent of the participants approved the course with a minimum final grade of seven out of ten. The results of the group that answered the pre test evaluation (n= 58) are as follows: in the pre-evaluation, the average score was 37% (sd= 32.56), while at the post-evaluation the average was 80% (sd= 20.68), indicating a highly significant improvement of 43 percentage points in their evaluation ($p< 0.001$). The biggest changes were observed in the Colombia-National Learning Service (SENA in Spanish) group,

Table IV

Generic competencies and the description of the application level according to target groups identified in the study carried out in Colombia, El Salvador, Mexico, Nicaragua, Panama and Venezuela 2012-2015

Generic competencies	*Strategic group*	*Tactical/Operational*	*Community*	*Academic group/ Research*	*Academic group/Teachers*	*Academic group/Students*
Incorporate the EA in the prevention and control of VBDs.	Lead social, intersectorial, and community participation for the prevention and control of VBDs.	Engage participation of community and other stakeholders in VBDs control and prevention programs.	Acknowledge the benefits of individual, family, social, community and municipal participation in VBDs prevention and control programs.	Generate scientific evidence on the sustained benefits and advantages of Ecohealth in the prevention and control of VBDs.	Build partnerships for academic collaboration with control programs, researchers and social key stakeholders for teaching-learning experiences of VBDs interventions with an EA.	Incorporate the EA in the conceptualization and design of strategies and interventions of VBDs prevention and control.
Identify VBDs' risk transmission factors.	Identify needs and risk transmission factors of VBDs to implement interventions with an EA.	Promote consensus with community leaders, authorities and the community regarding risk transmission factors and actions with an EA for VBDs prevention and control.	Understand needs and VBDs risks transmission factors and their relationship with the environment, in order to participate in VBDs sustainable prevention and control programs.	Generate eco-systemic approaches and research questions on VBDs with an EA.	Develop resources and teaching practices with an ecosystem approach to explain risk factors, determinants and interactions associated with the occurrence, nesting and focus of VBDs.	Critical analysis of VBDs transmission and its effective prevention and control with an EA.
Communicate the effectiveness of the EA.	Communicate the effectiveness of EA strategies for VBDs prevention and control to coordinate social, intersectorial, and community participation for prevention and control of VBDs.	Effectively promote the benefits and advantages of Ecohealth in preventing and controlling VBDs with communities and other stakeholders.	Communicate to leaders, promoters, and other key players program efficiency with an EA approach.	Communicate to colleagues, managers and funding agencies regarding the relevance of research on Ecohealth in VBDs.	Develop effective teaching-learning dynamics on the principles and benefits of EA in VBDs.	Disseminate relevant results of VBDs prevention and control using EA.
Identify opportunity areas to coordinate actions for the prevention and control of VBDs.	Promote and lead intersectorial and social participation for the implementation of VBDs control programs and projects with an EA.	Develop surveillance, prevention, and control operational activities of VBDs with intersectorial, municipal, community, and family collaboration.	Participate with local authorities, community leaders, organized community groups and NGOs in the prevention and control of VBDs.	Develop EA research in collaboration with control programs, key stakeholders, and regional initiatives for surveillance, prevention, control and elimination of VBDs.	Link the collaboration of academic practices with control programs and social key stakeholders involved with VBDs incorporating an EA.	Identify opportunities for applying an EA in the design, management and implementation of high impact VBDs strategies, projects, and programs.
Generate actions to promote public policies and financing of initiatives with the EA.	Lead the implementation of sustainable control strategies, projects and programs of VBDs and promote public policy.	Negotiate municipal and social leaders' cooperation with cost-effective actions for VBDs control with the community.	Participate in family and community actions to prevent and control VBDs with an EA.	Generate cost-effective VBDs interventions with an EA for prevention, control and public policy.	Incorporate an EA into VBDs academic programs	Promote EA interventions in VBDs based on evidence and good practices to influence public policy.
Incorporate scaling up strategies in EA projects for the prevention and control of VBDs.	Incorporate successful experiences and good EA practices for VBDs in public policy.	Negotiate regional scaling-up of successful experiences and community practices for VBDs prevention and control incorporating EA.	Promote with other families and communities, Ecohealth practices and experiences in the prevention and control of VBDs.	Develop research regarding scaling-up strategies of successful interventions for the control of VBDs.	Scaling-up academic Ecohealth programs in VBDs to institutions, universities and regional and international training centers.	Promote the implementation of successful Ecohealth interventions in VBDs for scaling-up in control programs.

EA: Ecohealth approach
VBD: vector borne disease

increasing its score by 67 points (from 33 to 100%, $p<$ 0.001); followed by the group of Mexico, which improved by 58 points (26 to 84%, $p=$ 0.060); then Central America with 43 (36 to 79 %, $p=$ 0.001), and Bogota with 31 (45 to 76 %, $p=$ 0.002); the complete results including 95% confidence intervals appear in table III. In general, these findings reveal that participants already had some competencies related to the approach, depending on their profession or based on their work experience.

The biggest changes were seen in groups that mixed academic and operational personnel from the ministries involved in training the workforce. This may be mainly because the operational personnel, who usually do not manage concepts, significantly increased their knowledge related to the EA pillars and improved more in the development of the competencies.

The main facilitating factors for the completion of the course, identified by participants, were: *1)* Their interest for acquiring the tools for improving the development and operations of their projects (understanding the benefits of applying the pillars of the approach), *2)* The dynamics during the face-to-face stage in which team activities were developed, and the participants exposed their points of view, *3)* The closure of each theme, hosted by an expert on the field who clarified doubts and information gaps and the local political support to develop EA courses and programs, *4)* The online monitoring with the assistance of experts for the development of the implementation project, and *5)* The tools with the objective´s description for each activity, as well as an assessment model.

On the other hand, the limiting factors for completing the course explained by the participants, mainly consisted of: *1)* The face-to-face stage required three complete days of activities, and some participants could not attend the whole workshop due to work assignments, *2)* Participants with a high responsibility level at work (decision makers) could not participate in the online part due to their lack of time, *3)* Participants belonging to the tactical-operative group did not always have the computer equipment and internet access to develop phases 2 and 3 of the course, and *4)* Operative and research participants' work related activities did not allow them to conclude the course on time, because they often have working activities outside their office or home.

Discussion

The attention of VBDs as a public health issue requires addressing the primary causes of their biological, social, and environmental determinants with innovative prevention and control strategies. To identify and assess the interactions of the high variety of determinants and to design preventive and control strategies, the participation of experts in several disciplines, along with communities and other stakeholders is necessary. The Ecohealth approach proposes holistic transdisciplinary and transectorial interventions to better respond to these requirements. However, the precise requirement of multidisciplinary teams presents difficulties for their integration when limited knowledge and precise roles for the different participating stakeholders are lacking.

To construct receptive-participative stakeholders, training emerged as the central element to advance Ecohealth in the region,[22] but there was a need to identify the main stakeholders and their competencies in order to direct capacity building. Our results present for the first time, based on the identification of the role-specific participants, the specific competencies required by each stakeholder group. The table of competencies, tailored to the organizational characteristics and the type and potential levels of contributions for EA interventions for each stakeholder group, provides guidance for the identification of common knowledge, but also the identification of group-specific skills. Although EA oriented, these competency classification could be useful for the integration of VBD control teams for other public health interventions. The identified competencies might only be significant for the region, but they present important insights for other groups working in EA.

Previously, very few Ecohealth courses had been conducted face-to-face in different countries. This article significantly contributes to the teaching of Ecohealth by defining in a more specific way the competences for each target group but also in the pedagogical approach of the course that included a replication strategy carried out by the participants as a pedagogical activity to develop competencies to replicate the course as tutors.

The identification of stakeholders and their competencies dealing with VBDs was useful to be more effective in the training courses. The collaborative, multidisciplinary and multi-sector approach for the identification of the competencies required time, effort and negotiation among the different parties. Even though there were different points of view, and even disagreement among the people involved, synergies were identified and a consensus was obtained. The regional collaboration and the multidisciplinary approach for developing these products ensured a cross-review and validation of the assignation of competencies for each stakeholder group and gained recognition among academic and health institutions

The adoption of the EA in the region requires better interaction among all different stakeholders involved in the policy making, prevention and control

of VBDs. A better understanding by the academic staff of the advantages and opportunities of the approach will favor its incorporation in academic curricula and research projects. The training of control programs operation personnel and health services decision-makers would make them more participative and receptive to interventions based on the approach. In the same way, a better understanding of the advantages of the approach would do the same for endemic communities and other members of the civil society.

The competencies model provided a definition of standards and expectations that could be clearly understood by the academic sector and health services managers, and can be used independently of the professional field. This facilitates the evaluation, guarantees the quality of services and serves as a basis for assessing future needs for training and continuing education of professionals as well as key participatory and VBDs affected stakeholders. The table of competencies, and its applications to target groups lead to the development of training materials, used in the training tutors' strategy, which has been very successful for constructing a critical mass of stakeholders dedicated to further advance the EA. An example of the materials can be consulted in the following links:

1) Participants guide: https://www.dropbox.com/s/d9a8o42osydfx2m/Guia%20del%20participante.pdf?dl=0
2) Syllabus: https://www.dropbox.com/s/g8flgpttadn3sig/FormatoC_etv_tutores_Final.pdf?dl=0;
3) Course: http://tie.inspvirtual.mx/moodle25/course/view.php?id=29&section=1 (Username: merida; Password: merida1).

The evaluation of results produced evidence to sustain that participants increased their knowledge of the EA in VBDs and that competencies are useful to guide development of training courses. These have been tested by the trained tutors when they replicated the course during the third phase of the training program. Training program acceptance is reflected on the participants request for a follow-up program in order to monitor their own implementation of EA courses.

Teaching EA competencies has already been adopted in medical and public health programs participating in the strategy, although the level of acquisition of these trainees awaits assessment; and it is now used for transdisciplinary research and training and the implementation of EA control interventions. Eventually this approach could be included in the curriculum of professional education and implemented in the training of professionals involved in VBDs programs. Further research on the table of competencies and the tutor's course is needed in other regions and endemic countries to develop the evidence of its effectiveness. An additional task to be completed will be the evaluation of the tutors based on both the replicas that they developed locally and measuring the impact on the reduction of VBDs.

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