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ORIGINAL ARTICLE

Teaching and learning for change: analysis of a post-graduate One Health program

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Abstract

As problematized through the One Health concept, global health issues are defeating conventional disciplinary approaches since they unfold across various scientific domains and across all levels of society. Calling for a change in the way knowledge is generated and used to tackle these complex societal issues, the One Health concept appears as a particular perspective within sustainability science. Various academic initiatives, inspired by the One Health concept, are emerging to prepare future health practitioners and researchers to think and work across disciplines. The building of adapted curricula faces important challenges, tied to the siloed structure of universities. Hence, the training initiatives are still in their infancy, facing an important uncertainty regarding field needs and goals to achieve. This study analyzes the main features and the impacts of a One Health-oriented program, starting in such an uncertain and siloed university context. The method combined participant observation and semi-structured interviews (individual and focus group) with four categories of actors: learners, teachers, partners, program designers. The narratives, reflecting the perceptions of the actors, were analyzed to propose an underlying visual model of the program. The main identified features of the program point to a continuous process of mutual adjustment between actors, available means, and projected goals. The program benefitted from interactions at several levels: between students, teachers, and external partners, to create an overall mutual learning dynamic. The underlying model is interpreted as an inherently evolutive structure, not only transmitting knowledge but actively co-creating knowledge, as would take place in a transdisciplinary research process.

Keywords One Health · Teaching · Integration · System Thinking

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Introduction

Global health issues such as emerging diseases and pandemic threats, antimicrobial resistance, food security and poverty-linked diseases, are paradigmatic examples of the so-called "wicked problems" (Rittel and Webber 1973). These problems are defeating conventional disciplinary approaches, since they unfold across various scientific domains and across all levels of society. Referring to the theory of complex adaptive systems, these issues may be characterized by non-linear interactions between a large set of elements, entailing uncertainty and unpredictability, then pointing to management challenges and the need for collaboration between disciplines to "harness diversity" (Cilliers et al. 2013). Diverse concepts have been proposed to tackle this complexity within the realm of global health issues, among which the One Health (OH) concept, pointing to the deep interdependency between the health of human, animals and ecosystems harboring them (Zinsstag et al. 2015). This interdependency makes system thinking crucial to tackle these global health issues, each of those being conceived as a network of interrelated problems involving diverse sets of expertise, professions, and stakeholders. Therefore, as it calls for a change in the way knowledge is generated and used to tackle these complex societal issues, OH appears as a particular perspective within sustainability science (Lang et al. 2012).

These new ways of thinking and acting call for an adapted training offers to help future health professionals implement such a system approach to global health issues. This paper analyses the experience of a post-graduate program aiming at this operationalization of the OH concept within an overall framework of sustainability science. The second section provides a brief review of problems around OH teaching and formulates the research question of this study. A third section describes the teaching program that served for this case study. The fourth, fifth and sixth sections present the study's methodology, results and discussion. A seventh section concludes.

The problem(s) of One Health teaching

Training needs to operationalize One Health

Realizing this system thinking approach to solve complex problems directly points to a need for interdisciplinarity and participation, which are combined and further refined in the framework of transdisciplinarity (Jahn et al. 2012). Therefore, to reap the benefits of the OH concept, the next generation of professionals, practitioners and scientists, need to be properly trained and skilled toward creative interaction with other disciplines and stakeholders, within a systemic approach. The emerging paradigm of OH thus calls for new competencies to be addressed in university curricula (Conrad et al. 2009; Frankson et al. 2016), for the design of new interdisciplinary programs (Hristovski et al. 2010; Bonfoh et al. 2015), but also the implementation of innovative educational methods (Eveillard et al. 2016; Putra et al. 2016).

Various training initiatives adopting the OH approach are currently being developed across the world (McKenzie et al. 2016; Pal et al. 2016; Reid et al. 2016; Rwego et al. 2016; Sikkema and Koopmans 2016; Stroud et al. 2016; Wu et al. 2016; Linder et al. 2020). These training courses, due to the emerging status of the approach, lack references or standards. This leads to the creation of a variety of models and strategies to train "OH practitioners". According to Lerner and Berg (2015), this lack of standardization is all the more accentuated as the understanding and definition of the concept are themselves diverse, which has consequences in the practice of teaching and research on this subject.

Teaching for inter- and transdisciplinarity, a perpetual challenge

The need to foster abilities for inter- and transdisciplinarity through university curricula has long been a concern for the modern academy (Neuhauser and Pohl 2015), thus well beyond the academic community involved in OH. This illustrates once more how the OH concept fits into the more general views of sustainability science or transdisciplinarity and how the concept could gain from being thought and taught as such. Indeed, the topic of teaching for inter- and transdisciplinarity is subject to a rich literature and is well covered through a diversity of handbooks presenting frameworks and case studies (Gibbs 2015a, b; Ertas et al. 2016). A set of experiences of transdisciplinary teaching were, for example, already presented more than ten years ago by Klein (2008), who pointed to the challenge of a "new quadrangulation of disciplinary depth, multidisciplinary breadth, interdisciplinary integration, and transdisciplinary competencies". In addition, bodies of work regarding these competencies in particular present different lists of skills and abilities required, stemming from various teams and areas of activities (Klein 2008; Neuhauser and Pohl 2015). While it would be out of the scope of this introduction to present in detail these frameworks and experiences, we may briefly highlight three main features. First, in terms of domains, as formalized in a similar concept of "Implementation and Integration Studies", these transdisciplinary competencies can be divided into three main categories: system thinking and complexity science, participatory methods, and knowledge management, exchange, and implementation (Bammer

2005). These domains then refer to a set of concepts, frameworks, practices, and tools that should fuel such an inter- and transdisciplinary curricula in terms of content. Second, in terms of structure, as summarized by Nash (2008), inter- and transdisciplinary curricula would present defined features, as a focus on a specific research problem, with a reasonably limited disciplinary scope, an individualized training plan, as well as team mentoring. To these structural elements, Nash (2008) adds that the challenges of transdisciplinarity (both in the learning and the future career) should be explicitly addressed through the program (what he calls "meta-training"). To translate this in terms of structure, such training would then have to devote time to reflexivity, including a reflection on the program itself. Third, besides the content and structure, we may point to the importance of self-management and interpersonal skills (i.e., the so-called soft skills) as goals for inter- and transdisciplinary teaching, which calls for active teaching activities (Moreira dos Santos et al. 2020). Fourth, as inter- and transdisciplinarity comes to engage creatively in the joint production of knowledge and design of solutions with other disciplines and stakeholders, we would like to point separately to the two fundamental abilities of creativity (Risopoulos et al. 2020) and ability to learn (Yeung 2015).

Problem statement and research question

Several difficulties impede formulating and implementing new interdisciplinary curricula (Turnwald and Walkington 2009; Linder et al. 2020) and are particularly relevant when trying to integrate animal, human, and environmental health disciplines throughout the teaching (Fenwick et al. 2009; Hristovski et al. 2010; Lerner and Berg 2015; Eveillard et al. 2016).

A primary issue lies in identifying the skills and competences to be acquired by the envisioned future health professional (Taylor 2009; Cribb and Buntain 2009; Risopoulos et al. 2020). Significant efforts have been conducted in this regard, having identified interdisciplinary and cross-functional skills enabling communication, collaboration, and system thinking (Frankson et al. 2016). This cross-cutting approach appears as a solution to the overloading problems generated by the aggregation of multiple disciplines. Nevertheless, it faces a lack of adoption within universities due to the same segmentation of academic disciplines, which is just mirroring and perpetuating the segmentation of professions. As for transdisciplinarity, the challenge appears even greater for universities, as they face current communication gaps between science and society, and between science and policy. Universities are therefore not well prepared to frame curricula with such cross-disciplinary objectives (McClam and Flores-Scott 2012). The question then arises about how institutions that are embedded in classical transmissive and

segmented teaching environments can move towards models in line with the principles of knowledge integration that are central to the OH concept and sustainability science (Hitziger et al. 2018; Apetrei et al. 2021).

The current study analyzes a OH-oriented professional master program at the post-graduate level, which faced the aforementioned challenges. From a qualitative enquiry conducted with the actors involved, this analysis aims at conceptualizing the way the program could evolve and generate change among its learners. Hence, the main features of the learning and teaching process are derived from participants' narratives and a visual formalization of the features is proposed. In line with Gendron and Richard (2015), the production of a visual support (schemes) is fully embedded in the process of analysis and synthesis that system thinking is calling for, and is needed for further academic discussions.

Presentation and structure of the training program

General presentation of the training program

The program is called Integrated Management of Health Risks in the Global South (IManHR). Situated in Belgium, it is co-organized by the University of Liège, the Free University of Brussels (ULB), and the University of Namur, in partnership with international actors such as the Food and Agriculture Organization of the United Nations (FAO), the International Center for Agronomic Research for Development (CIRAD, France) and the Afrique-One consortium (coordinated by the Swiss Center for Scientific Research in Côte d'Ivoire, CSRS), as well as partners in the non-governmental organization (NGO) sector. Organized over one academic year (60 ECTS, European Credits Transfer System), this program is accessible to holders of a degree in medicine, veterinary medicine, public health, pharmacy and bioengineering. Participants may benefit from a scholarship program, accessible to health professionals from low and middle-income countries. The program is taught in French or English, on an annual work-study basis, to reach both French-speaking and English-speaking southern countries.

The training is structured around 5 cross-cutting themes, addressed through different courses: (i) Antimicrobial resistance and drug management, (ii) Food security and food safety, (iii) Emerging, reemerging and neglected zoonosis, (iv) Disturbances of ecosystems, (v) Land use planning and health. These themes have been defined to highlight major practical challenges that are typically covered under the OH concept and anchor the disciplinary courses into explicit "wicked problems". The disciplinary contents are subdivided into eighteen courses, covering key areas of biomedical, veterinary, human health, social

sciences and techniques, including an important methodological and epistemological component.

The training period consists of courses held from September to December, the first exam period in January then courses in February and March. A two-month fieldwork is carried out in April and May. The fieldwork is carried out by interdisciplinary pairs, who finalize and present their graduation work together. The fieldwork has to integrate knowledge from the various courses. It is ideally carried out in a third country, with a partner organization. The month of June is dedicated to fieldwork debriefings, group activities outside the curriculum, and the realization of assignments, presentations, and exams corresponding to each course. The graduation work is then defended in September.

Program's objectives

The program aims at training practitioners and executives from public, private or non-governmental sectors for the field application of the precepts of integration promoted by the OH concept. Therefore, it is not aimed at research training. Its title aims at translating the OH concept into the more practical terms of "integrated management". The expression "health risks" is coined to cover a wide scope of prevention and control situations, including crisis management. It focuses on operational decision-making and policy-making situations in public services, NGOs, and the private sector, at the level of executives and field teams. The list of courses aims to cover the key aspects of analyzing situations and setting up interventions. In addition to a high level of technical knowledge, the program aims to place learners in the capacity to grasp the different facets of a complex situation, critically analyze data from published scientific information and government directives, as well as address and mobilize stakeholders to apply scientific principles to practical situations.

The program is organized around a central achievement, which is the ability to work in interdisciplinarity and with the participation of stakeholders. This competence, both central and composite, can be subdivided into a series of achievements: (i) Appropriate the framework of complexity and system thinking to identify analytical and operational complementarities between disciplines; (ii) Mobilize a conceptual approach to guide the exploration of a complex issue and the conception of solutions; (iii) Mobilize participatory tools and acquired social sciences for the understanding of stakeholders rationale, the co-analysis of the situation, and the co-conception of solutions; (iv) Carry out an interdisciplinary and participatory project in an entirely new context while demonstrating a reflective practice.

Teaching activities

Teachers use illustrated slideshows, videos, scientific articles, extracts from books, and reference documents from international institutions as teaching support. Also, some courses use conceptual maps (Cmap Tool software, Florida Institute for Human & Machine Cognition) which are co-constructed during group reflection sessions.

These supports are mobilized through a variety of activities. The seminars and testimonials from actors deliver the content necessary to nurture the analytical skills of learners according to the different disciplines involved (epidemiology and risk analysis, socio-economics, anthropology, statistics and modeling). Group reflections and exchanges of experience gradually exercise this analytical aptitude, mobilizing the different disciplines concerned. An aptitude for critical thinking is gradually built through this sharing of their personal experiences and the feedbacks by peers and teachers. Frequent exchange of ideas in the classroom strengthens the skills of co-construction. This process materializes at the end of the fieldwork through experience capitalization sessions.

Tutorials are carried out individually, in groups, or in pairs. Examples of those are the development of a biosecurity plan, a risk analysis, the development and defense of a conceptual framework, and the analysis of ethical questions linked to their fieldwork. Tutorials in interdisciplinary pairs, more particularly in terms of conceptual framing, socio-anthropology, socio-economics, and participatory approaches, help to strengthen the learners ability to co-construct in interdisciplinarity (within the pair and with teachers) in the face of a complex question in a new context. The exercises in participatory approaches, taking place after social sciences courses (socio-anthropology and socio-economics), allow them to develop practical skills and apply this knowledge in preparation for meeting actors in the field. Let us precise that social science courses avoid theoretical sessions and exclusively bring these particular insights to students through case studies and classroom discussions.

In addition to these classroom activities, real-life activities are organized, consisting of site visits (farms, slaughterhouses, research centers, reference laboratories) and practical work (laboratory diagnostic techniques, animal necropsy, spatial modeling exercises, statistical analysis, and crisis simulation). These visits and practical work help to familiarize learners with various realities as well as various techniques to understand their uses, requirements, and limitations. Thus, these exercises provide contact with contexts, actors, and occasions for further discussions and analysis, rather than mere applications of classroom theory.

Following the last exams and before the drafting phase of the graduate thesis, a participatory evaluation session of the program is organized by the program coordinator to raise

awareness on the fundamental learning points acquired in the master and the relative contributions of different courses and personal experiences. This session is also aimed as an opportunity to identify areas for improvement needed for the following year.

The structuration of soft skills acquisition through the program and through defined activities has not been subject to an explicit planning. Skills as teamwork, critical and innovative thinking are implicitly sought through the various activities of the program.

Methods of evaluation

The master's program favors evaluation based on work carried out alone or in pairs. Seven out of eighteen courses are carried out in pairs and assessed by an oral presentation, in front of a jury and audience of the class or during an examination in a single conference or interdisciplinary pair of teachers. Six courses are assessed through individual work without oral defense. This dominant form of assessment is in line with the analytical, collaborative, reflective, and communicational objective of the training. Five courses retain a classic examination, restitution of content, reflection, and exercises, of which four are written and one oral. They retain key importance in the experience and awareness of the need for rigor in the learning of the knowledge necessary for good management.

Methodology

This study is conceived as a reflexive exercise carried out by the actors of the training. A qualitative research method was adopted, consisting of participant observation, in-depth individual and focus group interviews.

Sampling and data collection

Participant observation

A phase of participant observation where the first author (DIS), followed all the stages of the training as a learner from the selection of the candidates until the realization and public defense of the graduate thesis. So, he participated in all the teaching activities and exams of the program. All the interviews and data analysis pertaining to the 2017 interviews were carried out by the first author of this study. Interviews conducted in 2020 were jointly handled by DIS and the second author (TJI), who has followed the IManHR program in the academic year 2019–2020.

Interviews and Focus groups discussion

The actors were identified according to the objectives of the study and their direct involvement in the process. Thus, four groups of actors were identified and interviewed: (i) the designers, who conceptualized the training project, from design to implementation ($n = 3$); (ii) the teachers and experts responsible for imparting knowledge and skills ($n = 11$); (iii) the learners, health professionals from low and middle-income countries ($n = 14$); (iv) external partners, hosting students' fieldwork ($n = 4$).

The investigation was conducted in two phases. A first phase, involving semi-structured individual interviews of all learners, teachers, and designers, took place between March and April 2017, during the start of the program. Interviews with learners were held before leaving for the internship, i.e., at a time when part of the program had not yet been carried out (in particular, the fieldwork, capitalization of experiences, and a crisis simulation). Therefore, complementary interviews were conducted at the end of the training. A second phase consisted of an impact survey, interviewing the learners in May and June 2020, almost 3 years after their graduation. The training coordinator was also interviewed in this phase, about the impact of the training on the organizing institutions.

Adapting the topics to each actor category, the complete interview guide covered the process of formulation of the program, the motivations to participate and expectations, the prior and current perception of the OH concept, the own experience of participation and degree of satisfaction, the assessment of weaknesses and strength of the program, and the impact on own activity.

In addition to individual interviews, two focus groups were carried out with learners: a group of eight learners, consisting of doctors, veterinarians, and agronomists, and one of six learners, consisting of doctors and veterinarians. Using participatory methods, focus group facilitation mobilized visual representations to ease the participants' expression.

Data transcription and analysis

All interviews were recorded and fully transcribed for thematic analysis. The data analysis was based on the work of Blais and Martineau (2006) describing a method of inductive analysis of qualitative data and the identification of emerging categories (Thomas 2006; Blais and Martineau 2006). This technique is particularly suitable for analyzing data on exploratory research objects, in the absence of predefined analytical categories. It makes it possible to develop a frame of reference or a model based on new emerging categories (Blais and Martineau 2006). This process was carried out on full transcripts using qualitative data processing software

(MaxQDA v10.4.16.1). The results of the case studied were first organized according to the actors to highlight linking and convergent elements or not.

Visual representations of the main features of the teaching and learning process were then produced by co-analysis and conceptualization of textual results (all co-authors, except DF). The final work was then subject to an external analysis by an education sciences specialist (co-author, DF).

Results

Program initiation, organization and their difficulties

The training project was initiated following a call from a national donor organization. As defined by the donor expectations, the initial objective centered on the idea of changing the professional practices of future learners and promotes a generation of "change-makers".

The partnerships were established based on pre-existing collaborations. Through the three partner universities and other partners, the coordinators brought together volunteering colleagues from various disciplines. The aggregation and structuring of the training offer were made by establishing from the onset, the need to cover the five transversal themes (see description of the program) seen as the necessary interface between the different courses. The units were formed by aggregating proposals of isolated teaching activities, formulated around case studies, entered by teachers in a matrix where the rows were the general scientific fields, and columns, the five transversal themes. The possibility of proposing activities outside of the five themes was left to one's choice.

Paralleling this offer process, an analysis of local needs was launched by e-mail consultation. This included a set of partners, with a long-term collaboration history. Answers confirmed the importance and timeliness of the topic but did not allow guiding the formulation process. Therefore, the formulation has remained dominated by an offer mechanism.

The constitution of the program presented difficulties. First, the request to include the training offered within applied themes appeared to be an unusual and confusing process for some. Also, some teachers perceived their subject as requiring more fundamental, "non-thematic" lessons, thus not lending themselves to the game of identifying relevant study cases. The creation of multi-teacher units by aggregating complementary offers then required an effort to spur a unit ownership by the coordinating teacher. It has also resulted in management complexity. The process resulted in the definition of 18 units, a number that is perceived as too large by the coordinator and learners. Despite these limitations, according to the coordinator, the advantage of the

mechanism has been to maintain the broad participation of a diversity of teachers.

Profile of participants and their mutual appreciation

Profile of teachers: diversity and experience sharing

Teachers presented a diversity of backgrounds, pertaining to veterinary, medical, social sciences and one from philosophy. Environmental specialists had only brief interventions in the program and could not be interviewed. Trainers displayed a wide range of years of experience, from early to late-career. All presented a research or teaching experience in collaboration with low- and middle-income countries. The main motivating factor declared by the teachers, apart from the stimulating nature of the project theme, was the sharing of their experience and mutual learning. The learners recognized that the team of teachers had sufficient skills and experience, also in terms of international cooperation. For both parties, this experience facilitated interactions, allowing for mutual understanding.

The diversity of teachers and disciplines was greatly appreciated by the learners. The latter identified the usefulness of the combination of these disciplines in tackling cross-cutting themes. Thanks to this diversity, the learners claimed to be able to better understand the contributions of each discipline. Nevertheless, disciplines were also identified as missing by learners and teachers (mainly in the realms of environment, policy and management). At the level of coordination/designers, contacts had then been taken with the needed experts to consider their addition to the program. This addition was envisioned in the constraining limits of the current structure. Hence it had not been translated in a formal change of the program at the time of this analysis. Such a deeper change was envisioned for the reformulation to be processed after a first 5-year term.

Profile of learners: diversity and multicultural learning

The program promoted the formation of a multicultural group of learners with professional experience. All of the learners recognized that their personal experience had been acknowledged and mobilized through the training. Trainers particularly appreciated the learners' motivation and their ability to share a significant professional experience.

There was a collective feeling of integration into a group, an important dimension in the learning and development of each learner. Diversity in geographical origin was said to promote interactions by stimulating mutual curiosity. This importance was expressed during group discussions as strong and positive visual ratings ascribed to relational aspects.

The selection process explicitly integrated this objective of diversity and formation of a coherent group, in terms of balance and complementarity of profiles (country, basic training, professional experience, gender). The selection targeted a narrow spectrum of professional profiles, i.e., medical doctors, veterinarians, and agronomists. The learners thus presented a limited heterogeneity in terms of qualification. The program, therefore, appears to be based on a principle of wide disciplinary diversity of teachers with a restricted diversity of professional sector at the level of learners.

Skills on One Health prior to the training

The teachers' vision explicitly and repeatedly invoked the One Health concept, which was directly related to an interdisciplinary approach. The concept is also translated in terms of a "holistic" approach or referring to the "complexity" of health issues. The concepts that are derived from this are "openness" to other disciplines, the "search for complementarities" of skills, and the "added value" of collaboration.

Prior knowledge of the learners on the OH concept—however motivating the master's program they applied for—was diverse but generally weak. Over half of them (8/14) said they had no knowledge of OH prior to training. The others admitted a superficial understanding. Through the training, the learners seemed to have built their own vision of the concept, with a certain diversity in their interpretations. To define the concept, the majority (11/14) spoke of the integration of disciplinary practices, expressed as "breaking down barriers" or even "pooling knowledge and resources". The concept was seen as applicable at a global level, a population level, and also at the level of individual care. The concept was further described as a tool for "comprehensive case management".

Perception of the teaching program and methods

Topics taught: appreciation, perceived imbalance and lacks

The program appeared to be sufficiently comprehensive in the opinion of the learners (8/14). Their assessment of the degree of completeness of each of the five themes, through the two focus group discussions, expressed both concordant and discordant results. The degree of completeness of the topic of "food security and food safety" was thus evaluated at 80% in the two groups. The insufficiencies in the teaching of the theme on ecosystem disturbances were pointed out by the two groups, attributing degrees of completeness of 30% and 20% respectively. Opinions differed on the topic of "antimicrobial resistance and drug management", receiving, on the one hand, an estimate of 80% and the other 40%. The unequal coverage of the different themes was also regretted

by the coordinator: "The themes are still under construction; it is a process that takes time".

The quality of the teaching was rated by all the learners as excellent and of great relevance to their needs. Gaps were identified in terms of "management science" (project management, management tools…), underlining the importance of this term to them in the title of the master. The internship and group activities had partially fulfilled this expectation at the end of the training. Some learners, however, still reported an unmet expectation of structured content about management. Others stressed that "management" was present throughout the master's courses, not in one dedicated course. According to this view, it was up to each one to formalize the acquired knowledge according to his/her practical needs.

Course preparation and teaching: teachers' intention and learners' appreciation

For around half of the teachers (7/11), the main objective of the courses was to raise "awareness" among the learners about the importance of some disciplinary insights. Other trainers expressed a goal of "integrating" their discipline into the set of knowledge and know-how that was useful to these professionals. Teachers described a variety of teaching development strategies, grouped into four categories. Each category highlights a distinct approach to teaching. The most described strategy consisted of a benchmarking on what others gave, to assure that the whole content was sufficient, and repetitions were avoided. Another strategy insisted on broadening the learners' range of thinking albeit a trade-off on a necessary depth of knowledge. A third strategy relied on flexibility, gradually changing the course content based on feedback from learners. A final strategy focused on the balance between theory and field activities. Besides these four strategies for the elaboration of new courses, a minority of teachers sought to apply an already existing course outline.

Throughout the program, active learning was promoted through experience sharing, presentations in pairs as well as classwork in groups or teams (including the final thesis). This was done to promote interactivity between students, teachers, and external partners where fieldwork took place. Simulations and serious games were also used but in tentative forms, being still in their early development stages.

A slight majority of the learners (9/14) expressed an unrestricted appreciation of the teaching methods, judging those as "perfect". The most cited qualities were the interaction or integration between disciplines, as well as the competence and openness of the teachers. The relationship between learners and teachers, also cited among the positive points, had been discussed during the two focus groups where it received a degree of satisfaction of 90% and 70% respectively. Weak points were mentioned as well, with three

expectations mentioned twice: more content that would be specific for developing countries, a better coordination within multi-teacher teaching units, and more field activities.

Classroom dynamics and the learning process: engagement and motivation

At the start of the training, the learners followed a week of classroom activities to introduce the training objectives, the five themes, and the complexity of health issues. This week also included spaces for discussions with a philosopher on epistemological notions, posing the difficulties of knowledge, its diversity, and its relationship to action. Expressed by learners as an immersive experience (without using that precise term), the week raised new questions to their minds, realizing the need to question their established practice. It appeared to launch the learning process in two modes: creating a collective experience and group dynamic, triggering a deep questioning and motivation for the remainder of the program.

The teachers greatly appreciated the strong motivation of the learners' group, the quality of the conversation, and their interest in the exchange of experience amongst the learners. These interactions seemed necessary to them for the realization of the OH concept. The teaching approach was clearly expressed as a co-construction by one of the trainers who said: "Here we are not in the classic academic perspective. The teacher knows what he is going to talk about but does not always know what he will share. He is in front of a class of professionals from diverse disciplines and so it's about leveraging all of this and building together". The size of the group, the mix between three professions, and the balanced distribution of fields were noted as features favorable to this dynamic and to the success of the courses. The teaching carried out seemed more difficult to imagine with a larger or more heterogeneous group. The anticipated difficulties stemmed from the requirements and the necessary adaptation of the subject to the diversity of profiles. These fears were voiced by teachers of biomedical subjects only.

According to the various feedbacks, the quality of the group was therefore due to a controlled heterogeneity, ensuring a balance between profiles and professional interests. This formula was seen as stimulating active exchanges, as a result of diversity, while still allowing for effective transmission, thanks to the well-characterized audience's backgrounds and needs.

Impact of the program: after training and 3 years after graduation

At the end of the training, all the learners agreed on the real possibilities of transferring the knowledge acquired from their training. They all anticipated a positive impact in terms of a change of mindset, better practice in the field, and openness to other disciplines.

Three years after returning to their work environment, the nine learners who were able to respond said that they had been able to apply their new skills and often called on other disciplines to solve problems. Confronted with situations of preventive management of health risks or a health crisis, they felt that their behavior had definitely changed in the field. They realized these changes upon their return to their respective countries. They had thus initiated readjustments in their professional environment to facilitate the implementation of their new skills. The training had contributed to job changes for most of them, within the same or different organizations. The training had stimulated a broader openness to other fields and the desire to continue this discovery was still mentioned in these testimonies three years later. The learners also showed a strong desire to make the most of all the skills acquired, even if it led to a change of role. Some (6/9) were still considering supplementary training or job changes (5/9). A few, nevertheless, claimed, at the time, to be in perfect harmony with their work. Progress was also noted at the level of organizations where the learners worked. A majority of the learners (8/9) said that their training had led to progress in their organization. These advances were in terms of expanding the volume of activities, providing better quality service, or even increasing the number of services offered.

The impact on the organizing universities was also considered very important by teachers, highlighting the gain in terms of interactions between colleagues during the master's degree and the deepening of interdisciplinary dynamics. These interactions materialized through the creation of several collaborative projects.

The international network dimension of the program was also cited. After the graduation of the first cohort, the coordinator set up a discussion group via a social media application to support the alumni. This group made it possible to prolong interactions by following everyone's progress, being updated on health risk situations faced by the alumni, as well as sharing content of interest, how they have handled. This discussion group having aggregated the graduates of successive years represented a link between the different cohorts. Also, a first webinar of the alumni of the successive cohorts was organized in summer 2020.

Partners' perspectives

The partners recognized the learners' professional attitude and their ability to adapt to different working conditions. Some key qualities identified by the partners were the ability to manage unexpected situations, to lead and organize work, and a developed interpersonal skill set. Some testimonials

highlighted the interns' disposition for innovation and critical thinking.

The partners pointed out challenges related to the design of the training. These challenges were mainly linked to cultural or linguistic barriers, due to the choice of sending learners in third countries. Also, the time for preparation of the fieldwork was considered too limited, especially concerning administrative or diplomatic procedures with their own partners. An additional challenge lied in the fact that the pairs developed a personal approach of an issue, based on their new insights gained from interdisciplinarity. This resulted in a lack of integration of the studied topic and approach in the partners' planned activities. This led to difficulties in financing activities or involving human resources to accompany the learners. A disadvantage of working in pairs was occasionally noted due to an imbalance of capacities between two trainees, which had caused a "wait-and-see" attitude from one of the two learners.

The partners considered the orientation given to learners by the training very suitable for international institutions, public services, and Non-Governmental Organizations, where the need for an open approach to complex issues was well perceived. The ability of learners to derive constructive insights from a participatory analysis was thus appreciated. However, it appeared less easy to implement in a more classic scientific research framework, in which the habit was to ascribe to trainees a specific question for which they would have to collect and/or analyze data along a defined protocol. Hence, the open and flexible methodologies developed by the learners would correspond less to the expectations of the latter.

Training model: interpretative diagrams

The elements gathered through this analysis were assembled into visual representations, to serve as basis for further interpretation of the program. These visuals are shown in Figs. 1, 2 and 3. Together, they may be considered as a proposed "model" intended to guide the future launching of such initiatives and their gradual improvement.

Figure 1 tackles the start of the process, showing the central role of a dialog between the composition of the team of teachers and the definition of the target audience. The context is proposed to be marked by two main characteristics. First, it is marked by an uncertainty regarding the needs, due to the diversity of realities to address and the complexity of the issues at stake. Second, the university context is schematized as showing a disciplinary segmentation and being dominated by transmissive modes of teaching. In this context, the program must be designed to allow for its rapid adaptation through a collective learning and adaptation process. This context appears as highly demanding for the teachers, which calls for the team to be composed of voluntary members, showing a personal impetus towards the program's goals. The initial team is thus composed under the double constraint of the availability of relevant expertise, the presence of a shared motivation and some ability of the involved teachers to play a facilitating role in active teaching activities. The definition of the target audience has to be tackled in parallel as it contributes to the motivation of teachers, hence to their identification. Therefore, defining the target audience must be discussed among a first team of interested teachers. According to their perception of field issues and needs, the definition will evolve with the evolution of that teacher group. As a response to the same context, the target audience has to present a balanced diversity to fuel an expected group dynamic. This targeted diversity will then be actualized in the selection of learners, which will have to constitute a group that fosters individual learning. According to this analysis, the degree of diversity in the group is a strategic factor for the training. In the present case, some heterogeneity proved successful to guarantee

Fig. 1 The context (dotted boxes) leads to a need for an evolutive program, which will translate into a dialog between the teaching team constitution and the definition of a target audience. Diversity and defined qualities in both groups (gray boxes) appear needed to fuel a group dynamic (dotted gray box) that will sustain the joint motivation
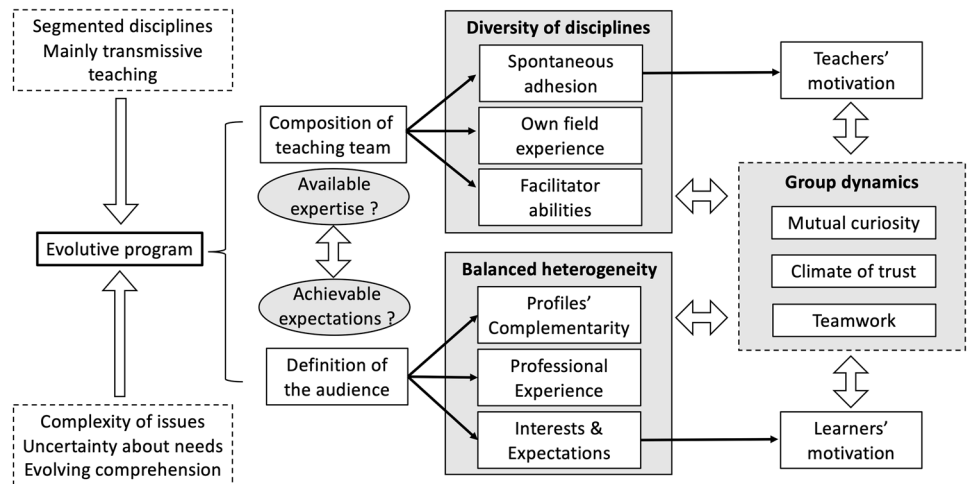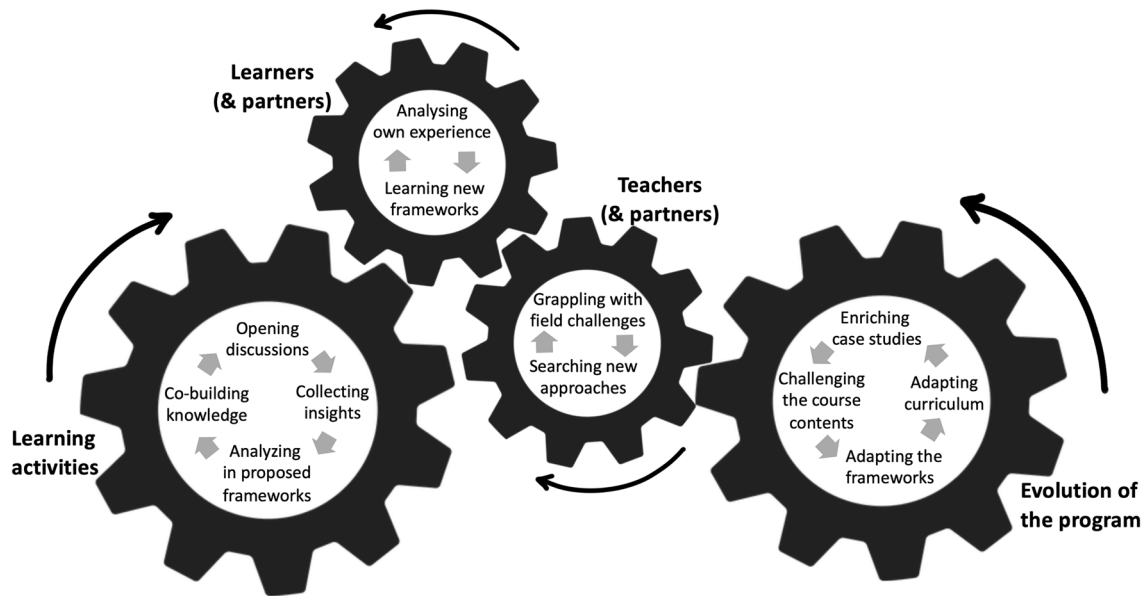
Fig. 2 Active learning activities foster a movement of which learners and teachers will derive two mutually dependent but distinct interests. This co-learning induces an evolution of the program, first through the enrichment of contents that will then call for a revision of the curriculum

complementarity in terms of background (domain, country) but also expectations. However, this diversity appeared constrained by the need of certain teachers to have some homogeneity in qualifications of learners to feel comfortable with their teaching. These two groups, learners and teachers, thanks to their respective attributes would ideally fuel the

Fig. 3 The interaction between the three categories of participants is shown to contribute to distinct qualities of the program and trainees, all contributing to train "change-makers"

group dynamics, which will be key in generating the needed motivation.

Figure 2 demonstrates the mechanics of co-learning between teachers, learners, and partners in the overall program evolution. Although this figure does not represent partners as a separate entity for the sake of clarity, those may be easily conceptualized as pertaining to either the dynamics exposed to the learners or the teachers, according to the peculiar attitude each partner adopts in his or her interaction with the program. The active learning activities, fueled by the group dynamics exposed in Fig. 1, are presented as providing a first impetus. This impetus is created by the opening of discussions that allow for the collection of a diversity of insights from the different participants. Those insights are then analyzed with the frameworks proposed by teachers. This finally allows for the co-building of new knowledge. This knowledge will be the basis of the next discussion within each course and sometimes between courses. Through these activities, two interdependent types of movements may be proposed: the learner and the teacher type, to which partners may equally pertain. The learner type focuses on field needs and consists of a continuous re-interpretation of individual professional experiences through the light of newly acquired frameworks, concepts as well as learning experiences.

The teacher type focuses on the re-working of theories, frameworks and concepts through the light of the diversity of cases that the learners are bringing. The teacher is shown as grappling with these proposed field issues and is required to seek new insights from own or from other disciplines.
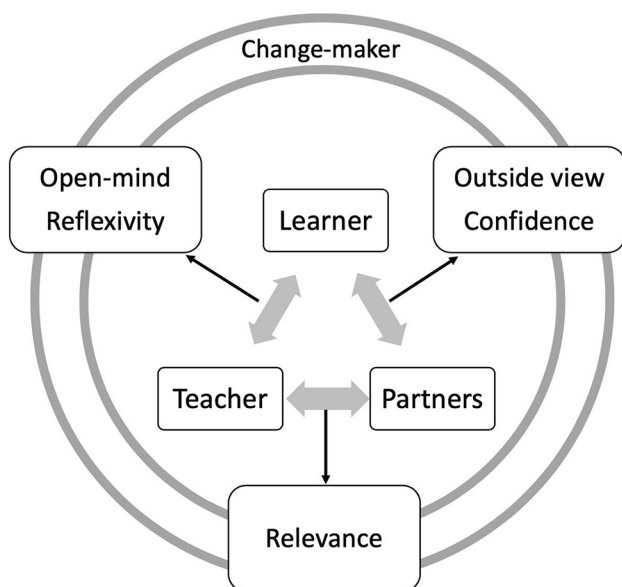
The latter dynamic will particularly fuel the programs evolution by leading to an enrichment of the case study basis, the evolution of contents and frameworks, hopefully through an interdisciplinary or transdisciplinary approach. In the present case, the content appears to evolve annually while the full curriculum has to be revised every 5 years.

Figure 3 addresses the sources of skills/qualities needed to become "change-makers". It considers the societal dimension of training, carried out in partnership with external actors, taking account of the needs in the field, and contributing to the co-learning. Thus, the training, according to the fundamental objective required by the funding institution, goes beyond the mere improvement of trainees' practice and makes them facilitators of change in their professional activity. As shown on the figure, the needed qualities result from interactions between the three types of actors. The interactions between learners and teachers, during classroom exchanges and visits, aim at opening the mind of learners to the need for interdisciplinarity as well as training them for critical thinking and reflexive practice. The interaction between learners and partners will create an environment for testing, adapting, and validating the newly acquired attitude from the master's program. Learners will be trained to bring an outside-in perspective while considering the partners' point of view on their own expertise. This process of building mutual confidence between the learner and the partner would contribute to building the self-confidence of the learner and his/her ability to bring valuable insights. Direct interactions between the teachers and the partners are finally important to make sure that the program increases its relevance to needs in the field so as to increase the relevance of the learners' expertise in the field. These interactions appear as the foundation of the approach developed by the program, allowing its observed impact and its evolution, by confrontation with field needs and partners' insights.

Discussion

From the teaching activity to the learning process

This study formalizes the setting up of a One Health program in a context marked by constraints abundantly reported by the literature, i.e., uncertainty about the needs, segmentation between disciplines and dominance of classical, disciplinary and transmissive teaching (Turnwald and Walkington 2009; Fenwick et al. 2009; Hristovski et al. 2010; Lerner and Berg 2015; Eveillard et al. 2016; Linder et al. 2020). It is intended as a reflective exercise by the team involved, building a positive scheme around the elements of the master which make up its current strengths. This visualization makes it possible to question the coherence of the program as a whole and identify its weaknesses.

According to Altet (2000), the analysis of teaching practices is not often centered on learners. Here, the perception and appreciation of learners played a crucial role in identifying and understanding the main features of the program contributing to its impacts. This involvement of learners in this analysis mirrors their active contribution to the program, which is based on continuous exchanges and mutual adaptations between teachers, learners, and external partners. The diagrams elaborated on that analysis suggest an evolving nature of the program, which can be considered as a basis set for future developments rather than as a sum of knowledge and know-how to be transmitted.

This analysis of practices did not go deep into the specific activities making up the master's degree, despite the reported importance of such active methods in OH teaching (Eveillard et al. 2016; Putra et al. 2016) and learners' motivation (Viau 2009). It rather focused on a general vision of the program to identify the constituents of the observed impact. Using point-in-time interviews, it overlooked the dynamic of learning throughout the year. Hence, two options to further examine the program are (i) the detailed analysis of active learning devices (serious games, simulation, case studies, capitalization of experiences), and (ii) the processual analysis of the learning path as experienced by the learner. The lack of the latter perspective actually creates a gap in the present model. Indeed, if the learners are central in the program evolution within a year and across years, the program evaluation should consider their feelings over time to identify key moments or gaps along the process. Such a monitoring tool, e.g., in the form of a portfolio, would add significantly to the consistency of the program.

Strikingly, throughout the open interviews, learners did not spontaneously put forward their personal work in preparation of their fieldwork as a major element in their learning during the year. Hence, the first focus in their discourses was put on courses and teaching activities as being their source of learning. However, the central role of the field appeared from partners' interviews and also from learners' testimonies three years after graduation. Thus, it may be hypothesized that the fieldwork acts as an integrator of all the learning and a catalyst for the personal development of the learner, but in a more diffused and less identifiable manner. This role in the learner's maturation might also have been understated because of the classic structure of the thesis (introduction, methods, results, discussion) that does not allow the student to express, analyze and anchor this complex and diffused learning. Also, this structure does not provide the teacher with the opportunity to follow the thread of this development in depth. Hence, this result points in fact to a weakness of the analyzed program that appears to unintentionally downplay the role of field preparation and field experience in the learning. To reinforce the transdisciplinary dimension of the master, it appears important that this gap

is filled, and that the importance of field preparation is fully recognized as a learning time by learners and teachers. This probably will call for a translation in the organization of the year, with enough time being dedicated to this activity and displayed in the schedule. Again, the re-structuration of the final work under the form of a portfolio would help, by not only focusing on the end result but documenting the process.

A One Health program? Imbalances and perspectives, completeness and integration

The question of the imbalance of teaching between the five proposed themes was pointed out by the students. This imbalance resulted, in particular, from the program formulation by offers of expertise by a pool of volunteering teachers. In addition, the imbalance also resulted from a perspective of the main partners on the core objectives of the program and the choices made in the face of practical constraints. The development of a OH program requires any institution to position itself according to its strengths to produce an original offer which then turns out to be complementary rather than in competition with other programs (Mor et al. 2013; Linder et al. 2020). This role of expertise availability and volunteering has been pointed out in the interpretative schemes as showing founding effects on the program (Fig. 1). A trade-off then appears when engaging in this dialog, between the available expertise among volunteering teachers and the definition of the target audience and scope. Indeed, strictly maintaining the envisioned scope/audience within the zone of mastery of the available expertise will reinforce the satisfaction of learners from a disciplinary point of view, but it will fall short of creating the conditions for future interdisciplinarity that those gaps are calling for.

In any case, notwithstanding the need to strive for better coverage, a OH program will always have its shortcomings as it can only present a particular perspective to such a vast concept. This awareness of the learners about gaps in the program even appears as a fundamental quality of a OH practitioner who will have to be able to identify and mobilize the missing expertise. This awareness of the complexity of health challenges, their intricacy, and the vital need for interdisciplinarity is the objective of the first week of the learners' immersion into the core of the five themes. As such, awareness of shortcomings in the program they follow signifies the successful acquisition of this primary professional quality. This awareness is all the more appreciable as the learners said they were not familiar with the OH concept before starting the training program.

In addition to the incompleteness and imbalance, critiques arose on the internal organization of the elements taught during the courses or the themes. The idea of a reorganization was proposed by the learners. This translates the difficulty in structuring a OH based curriculum (Turnwald and Walkington 2009), in which the teaching units are so intertwined that they can be equally placed in different thematic units (Eveillard et al. 2016). Whatever the choices that are made regarding this structuration, it appears here that their debate with learners may be rich, being an opportunity for discussing the interconnections between issues, eliciting their perceptions, and as a practical exercise of critical thinking.

Selection and motivation

The objectives of the training must meet different expectations, including that of the teachers guiding the training program. However, these expectations did not appear here as mutual constraints but may be seen as the convergence of different aspirations. Thus, with a mutual objective of the teachers and the funder, a training program is created based on its relevance for a certain audience. As highlighted in this analysis, this process is hardly manageable in a directive and linear way. Rather, it results from a dialog—or even a negotiation—between volunteering teachers according to their respective interests and perceptions of the needs of practitioners. Once the target audience is defined, the participants will then be identified and enticed by well-targeted communication. Hence, the selection appears to be the decisive step in the success of the training program, by ensuring the congruence or complementarity between expectations of all participants, which will contribute to spurring a positive group dynamic.

Indeed, throughout the training, the group played a facilitating role in the learning of each of its members through the strong cohesion and climate of trust. These positive group-related effects have also been highlighted in similar training programs (Linder et al. 2020). According to a socio-constructivist vision, the social framework is an important element of learning. Social interactions introduce a confrontation between divergent conceptions, making it possible to question oneself (Mugny 2008). This process is introduced in the first immersive week, through debates on the five themes and conversations with a philosopher on the subject of epistemology. These exchanges are indeed effective in creating an initial disequilibrium, setting learners' thinking in motion (Mugny 2008). These two features, i.e., the facilitated climate of trust in the group and the creation of situations where viewpoints may enter into dialog, are mutually indispensable to jointly enable group learning. Indeed, if the right climate of trust is not created, oppositions of viewpoints entail the risk of conflict, feelings of being offended and unreceptive attitudes.

This group dynamic is mostly due to the immersive dimension of the entire training, with learners being taken out of their family and professional environment for a full year. Bosque-Pérez et al. (2016) underline the importance

of immersion courses, promoting integration between disciplines. The relational dimension and conviviality turned out to be very important. Reinforcing it with the time devoted to group work and paired fieldworks created a positive dynamic. Professional experience is also likely to strengthen this dynamic. If the learner's experience is not solid the disequilibrium mentioned above is likely to create a feeling of doubt about his/her own skills causing a reflexive withdrawal or passivity. This is in contradiction with the interactive modalities of the program. On the contrary, the diversified professional experience of the participants allows them to appreciate and integrate the theoretical aspects of the program. This co-constructive approach also contributes to the creation of a strong relationship between learners and teachers. A general interest of each party in the teaching activity reinforces and contributes to general motivation.

Training as a transdisciplinary research project

This process of co-learning between the three parties (teachers, learners, and partners) links academic and non-academic actors in the creation of knowledge relevant to the realities and goals of each (Fig. 2). As such, this training can be interpreted as a collective transdisciplinary project, the forms of which vary between formal processes or informal occasions (Riedy et al. 2018). According to this view, the aim of this transdisciplinary research would be to explore the notion of "integrated management of health risks", to translate the concept into a body of knowledge that is socially robust, aiming to stimulate a large-scale change (Hoffmann et al. 2019). The active teaching and field activities cover the five stages proposed for transdisciplinary research by Hoffmann et al. (2019): (i) defining sustainability problems, (ii) producing new knowledge, (iii) assessing new knowledge, (iv) disseminating new knowledge in realms of both science and practice, (v) using new knowledge in both realms.

As highlighted in Fig. 1, the sustained motivation of both the learners and teachers is fueled by this group dynamic of co-learning, thanks to a congruence of objectives. However, this conjunction within a common dynamic does not mean that the respective interests in the co-learning are the same. As mentioned here above, the created knowledge may be mobilized in distinct ways by the different participants. This is visualized in Fig. 2, which stresses the distinct forces at play in the so-called "learner type" and "teacher type" of co-learning (partners being considered to pertain to the one or the other type according to their personal attitude or institutional interest, whether NGO, administration, university, or research center). These distinct forces may mirror the distinction made within transdisciplinary research frameworks between the societal and the scientific practices (Lang et al. 2012). If both meet in a joint process of knowledge production, the value of that knowledge is judged in different terms

by the two parties i.e., in terms of usefulness for the societal practitioner and of relevance for the scientific one. Considering the notion of "integrated management of health risks", the learners will be interested in how those frameworks and the co-analysis of their professional experience will inform their future practice, how this "integration" can practically tell them how to better manage complex health challenges and show them what they may have to change in their working environment or habits to allow this "integration" to happen. From the teachers' side, more attention will be paid to the improved relevance or polyvalence, hence generality, of the frameworks ensuing from those analyses. Obviously, those are the two sides of a same coin, i.e., complementary perspectives validating a newly acquired understanding of "integrated management of health risks".

The feedback from the partners clearly reflects this dimension of transdisciplinary research, both in the strengths and challenges encountered. Despite the discomfort created by an approach that deviates from habits, the link with field actors as well as the flexibility of the approach was greatly appreciated. The construction of a project topic by a pair of learners creates difficulties in terms of organization, allocation of human and financial resources, and the integration into pre-established operating processes. The partners, aware of these challenges, still confirm the interest of the knowledge created with the learners and appreciate the investments in this collaborative project. Thus, these fieldworks, going beyond the temporary hosting, must be part of a long-term partnership respecting the time of co-construction. In an idea of continuous adaptation, these challenges however signal a need for the program to evolve, particularly in terms of the provision of resources and standardization of the process of setting up the internship, to introduce a degree of predictability for the partners. Although the internship is an opportunity to put learners to the test, especially in the collaborative, intercultural, and adaptation dimensions highlighted by certain partners, work must be carried out so that these tests are realized under sufficiently controlled conditions to function as a "sandbox" for these future professionals. This means that each fieldwork appears as jointly established live experiments in which the principles developed in the program to operationalize an "integrated management of health risks" are tested to inform the subsequent evolution of the program.

The expression "integrated risk management", initially used to translate the OH concept into practical terms (Zinsstag et al. 2015), was first seen as summarizing the main orientations of training while leaving an opening for flexibility in the development of the program. However, the formulation of the program focused on the notion of "integration". Therefore, the reflection on the conception of the master's program focused on the necessary interdisciplinarity in its management, without further formalizing the expectations

raised by the term "management". This entails that the practical modalities of management itself, although present through the contents of all the courses, have not been clearly formalized in the educational structure. The end result is that learners do not feel adequately supported in the comprehension and further application of "integrated management" in their future professional activities. This need to explore the "management" aspect of the founding concept of the program is now leading to new interdisciplinary collaborations and to a re-structuration of the way the current teachers are mobilizing their expertise to address OH operationalization.

In reality, the OH concept still remains largely to be explored. The very nature of the concept means that many distinct applications can be deduced from it. Therefore, this framework of "integrated management of health risks" appears as the object to be co-constructed through the program, the educational process of which is essentially oriented on the stimulation of interdisciplinarity and participation. This interdisciplinarity, within a reflective practice, must then lead the graduates to develop strategies that are adapted to their professional framework. If the impact observed through the career development of the first graduates illustrates the usefulness of the approach, the ambition of the program is to aggregate the elements co-constructed over the years of execution of the master and formalize them gradually in its educational journey.

Interest of the model

We do not claim that a transdisciplinary research has been fully achieved through the present teaching program. Rather, the features presented here point to an incipient transdisciplinary research process. The interest of this observation is twofold.

First, as the program has taken such a format in an undirected manner, its promoters and partners may take advantage of getting collectively aware of the process that has been engaged to pursue it purposively. By doing so, the program may benefit from being further structured along frameworks initially built for transdisciplinary research and also draw inspiration from these frameworks for its evaluation. Facing the high costs of achieving transdisciplinarity (staff, time, coordination), Balsiger (2015) proposes to differentiate between four categories of transdisciplinarity to allow for a progressive effort towards its fulfillment. Here, cases are differentiated according to their degree of integration and collaboration in a two-by-two matrix. These categories can be mobilized to guide the future pathway to be followed by the present training program. Indeed, starting from a shallow integration and relatively narrow collaboration, the program can be thought as having started from the category of "soft transdisciplinarity" (corresponding to the first period of interviews) (Balsiger 2015). Over time,

through students' fieldwork and courses, the integration got deeper, moving the program towards the category of "reflexive transdisciplinarity" where it remains to be evaluated as the program is presently running. The widening of the collaboration spectrum around the program, both in terms of diversity of actors and depth of inclusion, would let it move, in the future, towards a "hard transdisciplinarity", or at least a harder one.

A second interest of the proposal is that it blurs the boundary between research and pedagogic design i.e., between the research and teaching activities of academic staff. Yet, this distinction between these activities and the pressure of academic staff to publish research work appear as important barriers to their involvement in teaching (Henkel 2004) and to transdisciplinarity in general (McClam and Flores-Scott 2012). The blurring of this demarcation would also contribute to strengthening the links between science and society, accepting that universities don't hold ready-to-teach solutions or even approaches to complex issues and showing that mutual learning is a great deal of what the modern world needs. This mutual learning between science and society, which comes as the ultimate goal of transdisciplinarity (Jahn et al. 2012), appears as a summarizing expression, translating into one realm both research and teaching activities.

Conclusion

This case study proposes an analysis of a OH-inspired program in a context marked by often-reported constraints of discipline segmentation in universities, dominance of disciplinary transmissive teaching practices, lack of connection of researchers to field actors, and an overall uncertainty about the needs to cover through the program. From the perspective of the different participants (learners, teachers, partners, designers), it derives a visual representation of key elements of the setting up, dynamics and continuous improvement of the program. As such these observations and interpretations should present a direct usefulness for different university actors interested in the creation of such interdisciplinary and participatory programs in siloed contexts.

On a more general ground, the proposed analysis embeds the OH concept within the practice of sustainability science to pinpoint commonalities and claim gains that would be achievable by bridging those epistemic communities. It also highlights the intricacy between teaching and research for teacher-researchers who are committed to contributing to knowledge integration, which is a common ground for OH and sustainability practitioners. The interpretation of the teaching program as corresponding to an effort of transdisciplinary research backs both assertions up. Indeed, the founding call of sustainability science to re-think our mode of knowledge production and use finds here an echo in the

experienced need to re-think the way we teach that knowledge. As the transdisciplinary practice may be seen as blurring the demarcation between knowledge contributions from scientific and societal practice to produce solutions to complex sustainability issues, the present experience of starting a master program that tackles complex health problems has compelled its promoters to blur the demarcation between teaching and research, and between teaching and learning. As in transdisciplinary research, this evolutive teaching acknowledges the mutual benefits to reap from collaboration between diverse sets of knowledge holders, for the sake of improving the societal relevance of the academic activity.

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