REVIEW ARTICLE

Preparing society to create the world we need through "One Health" education

Report of a global survey and web conference on "One Health" K-12 education, 18 November 2016

George R. Lueddeke[1], Gretchen E. Kaufman[1], Joann M. Lindenmayer[2], Cheryl M. Stroud[2]

[1] One Health Education Task Force;

[2] One Health Commission.

Corresponding author: George R. Lueddeke, Co-Chair, One Health Education Task Force;
Address: 9 Lakeland Gardens, Southampton, Hampshire, SO40 4XG, United Kingdom;
Email: glueddeke@aol.com

1

Abstract

Aims: A previous concept paper published in this journal (1), and a Press Release in June 2016 (2), focused on the importance of raising awareness about the UN-2030 Sustainable Development Goals (SDGs) (3) and, in particular, developing a better understanding about the critical need to ensure the sustainability of people and the planet in this decade and beyond through education. The One Health Education Task Force (OHETF), led by One Health Commission (4) in association with the One Health Initiative (5) agreed to conduct an online survey and conference in the fall of 2016 to engage interested colleagues in a discussion about the possible application of One Health in K-12 (or equivalent) educational settings.

Method: The survey instrument, reviewed by a panel of experts (below), was conducted in September and October 2016 and focused on basic concepts, values and principles associated with One Health and Well-Being. Input was sought on the various ways that One Health intersects with the UN Sustainable Development Goals and how they might work together toward common objectives. Questions also explored 'why, how, and where' One Health could be incorporated into K-12 curricula, and who should be involved in creating this new curriculum.

Results and Conclusions: Overall, there was general consensus that this initiative could make a significant contribution to implementing the SDGs[3] through the One Health spectrum as well as the priorities and major challenges that would be encountered in moving this initiative forward. Five strategies were presented for embedding the SDGs and One Health through curriculum innovation from early years to tertiary education and beyond. Importantly, a "Community of Practice" model was put forward as a means to support and promote the SDG goals through One Health teaching and learning in a meaningful and supportive way for the benefit of all involved. A subsequent conference in November 2016 provided an opportunity to present the results of the survey and conduct a more in depth discussion about potential curriculum development designs, possible project funding sources, and implementation challenges.

Keywords: education, One Health, global health.

Conflicts of interest: none.

Introduction

The *One Health* concept is rightly gaining timely support and momentum worldwide as we are all becoming increasingly aware that humans, animals, plants and the environment must be in much better balance or harmony to ensure the present and future of our planet. It is gradually becoming clear that to realise or indeed re-capture this state of equilibrium, One Health and Well-being must be at the heart of socioeconomic, environmental and geopolitical decision-making at global, regional, national and local levels, thereby informing, as the Commonwealth Secretariat Health and Education Unit (ComSec HEU) posits Governance, Knowledge Development, Capacity Building and Advocacy (6). Over the past 18 months or so, and in line with the UN-2030 Global Goals (3) (or Sustainable Development Goals-SDGs) agreed late 2015, that embraced a broad notion of sustainable development – how all things are interconnected – climate, energy, water, food, education -we have been researching and developing ideas on how the One Health Task Force might support sustainability of the planet and people. Our deliberations led us to the fundamental question of how we might address perhaps the most important social problem of our time, that is, *'how to change the way humans relate to the planet and each other to ensure a more sustainable future for all life.'* (2)

Our unanimous conclusion is that learning about 'One Health and Well-Being' needs to play a much greater role in the education of our children and younger generation as well as society in general. To these ends, we developed position papers, issued a Press Release (2) in June 2016, to which many webinar attendees responded, followed by an on-line survey In September-October to solicit wider input on One Health Education. The survey thus informed an online One Health Education Conference on November 18, 2016 (7). The main purpose of the webinar was to share and build on the survey findings with a view to informing a 'robust' One Health education project funding proposal. A vital consideration governing the proposal was the potential of raising awareness about the social determinants of human-animal-environment interactions as well as the limitations presented by an unbridled human population expansion in the face of finite natural resources.

Many of the task force discussions reminded us that while we are advancing scientifically and technologically, we are also faced with a huge ingenuity gap – that is finding answers to unprecedented social problems that on many days seem to overwhelm us – climate change, health and food security, armed conflicts, ideological extremism, economic uncertainty, global inequalities, inequities and imbalances, to name a few. The Ebola crisis especially caught the world's attention in this regard. There are no easy answers. But encouraging young people to gain a better understanding of the planet we all share and need to sustain, along with our individual responsibilities to each other, and learning not only 'to do things better' but also, perhaps most importantly , 'to do better things' through collaboration and education, must surely be part of the way forward.

Underpinning our resolve to engage children and young adults in the pursuit of achieving the UN-2030 Global Goals through education and the One Health Education Initiative (OHEI) is captured in the recently published book, Global Population Health and Well-Being in the 21st Century (8). A recurring theme in the publication is that achieving the 17 SDGs and targets requires a fundamental paradigm or mind-shift in the coming decades: moving us from a view that sees the world as 'a place primarily for humans and without limits' to one that views the world holistically, ensuring it is fit for purpose in the long run for humans, animals, plants and the environment or our ecosystem. *One Health* provides us with the 'unity around a common cause' (9) toward which all of us need to aspire and which we believe is fundamental to building THE WORLD WE NEED.

Summary of online One Health education survey results
The purpose of the One Health Education online survey was to elucidate concepts, values and principles that respondents associated with One Health, and to begin to define how the One Health concept might be operationalized in K-12 schools. Invitations to participate in the survey were sent to individuals that had previously expressed interest in the One Health K-12 Education initiative expressed through presentations, in response to the published concept note and a press release, and through individual conversations. Seventy-six people responded to one or more questions on the survey. Of the 52 (68.4%) respondents who answered the question about highest level of education attained, 31 held one or more doctoral-level (18 PhD, 9 DVM, 4 MD, 1 JD), 14 held master's-level, and 7 held bachelor's-level degrees. Of the 53 (69.7%) respondents who answered the question about country where they worked, 21 answered USA, 15 Europe (including 6 in the UK), 10 Africa, 5 Asia or Southeast Asia, 1 South America, and 1 answered Middle East.

One Health concepts, values and principles
Words that respondents most commonly cited were "health" and the health domains (human, animal, environment/ecosystem/ecology). Respondents also cited words that represented common ground among One Health disciplines, e.g., inter-, coop-, collab-, coor-, integ-, uni- and holi-. "Sustain" and "educ-" were mentioned frequently, as were "dise- and "zoo-."
Respondents preferred the Venn Diagram and Triad representations of One Health by far over other representations.
Values most commonly cited as most essential to One Health are sustainability, cooperation, diversity/biodiversity and responsibility, leadership and understanding. Innovation was also noted.
The type of sustainability judged to be the most important type by far was ecologic sustainability, economic and cultural/social only moderately so.
A high degree of agreement (>90%) was given to the following statements: "*The health of humans, other animal species and plants cannot be separated,*" and "*Environment includes both natural and built environments.*" More than 80% of respondents agreed that "H*umans have a moral imperative to address One Health challenges,*" and "*One Health should be practiced so that there is no net (ecosystem) loss of biological diversity.*" More than two-thirds of respondents agreed with all other statements except "When you optimize health for one species, health for others is marginalized or eliminated." This implies that the health of species is inter-related and should not be viewed as mutually exclusive.
The factors contributing most to current One Health problems are compartmentalization of health services and policies, lack of knowledge/understanding, lack of funding streams that encourage collaboration and provide support for One Health initiatives, poverty-distribution of wealth-inequity, overemphasis of treatment of individuals (human and animal) at the expense of preventive medicine and population health, political systems that support individual/corporate interests above all else, and overemphasis of human health at the expense of animal/environmental health. Other factors mentioned were that One Health was too veterinary-centric and that there was a need to acknowledge differences between the developed and developing world.

One Health education and the SDGs
Respondents related K-12 education most closely to SDG 3 (ensure healthy lives and promote well-being for all ages). Also related, although slightly less so, were SDG 14 (conserve and sustainably use the oceans, seas and marine resources for sustainable development), SDG 15

(Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification and halt and reverse land degradation and halt biodiversity loss), SDG 6 (Ensure availability and sustainable management of water and sanitation for all), and SDG 2 (End hunger, achieve food security and improved nutrition and promote sustainable agriculture). Other sustainability goals not included in the 17 SDGs included improving animal welfare, developing sustainable strategies for control of feral animals, invasive species and pests (to humans), moving to clean energy sources, developing new tools for impact assessment, and promoting greater intake of locally raised foods.

Operationalizing One Health education in K-12

Why?
Long-term outcomes of a One Health-themed curriculum included products (trained educators, better policies and decisions, multidisciplinary approaches to risk, sustainable environment/ecosystems/communities, successful adaptation to climate change, new disciplines, better communication, reduction of the gender gap, more recycling, project design competitions), changes in attitudes and behaviors, more and better engagement as citizens with policy and as consumers, and better health and greater awareness of human populations relationship with the planet and its inhabitants. A number of people anticipated that systems/interdisciplinary thinking would be an outcome.

What?
Students should be exposed to all concepts listed**,** although personal responsibility (how individual actions impact One Health) and respect for natural systems and human responsibility for planetary health were the most important, followed by environmental contexts of One Health issues and corporate, political and societal responsibility (how their actions impact One Health). One person noted that equity and social justice was important, as was the moral imperative of viewing nature as equally important as humanity.
Students in One Health-themed educational programs should learn collaboration, interdisciplinary thinking, systems-thinking, problem-solving and team-building skills. Entrepreneurship, environmental ethics were also noted. One person remarked that *"In my opinion, students in One Health must, before anything else, gain the ability to immediately look for solutions from all media when facing a problem that requires a more complex approach. Basically questioning themselves -- what would an engineer/medic/chemist/vet/etc. do when faced with the current problem?"*

How?
Challenges most commonly cited that could be used to illustrate One Health in K-12 education were diseases (vector-borne, zoonotic, food-born), food security, antimicrobial resistance, environmental pollution (of air, water, soil), climate change and loss of biodiversity/disruption of ecosystem services.

Where?
College and university students are the groups most exposed at present to One Health concepts (although fewer than 20% of respondents believed they were exposed at all). Fewer than five percent of respondents believed that students at all other levels of education are exposed to these concepts. Respondents believed that at levels below college/university, it's most important to introduce One Health concepts to students at all educational levels, although it's most important in high/secondary schools and slightly less so in middle schools.

One Health-themed curricula should be piloted in publicly-funded schools and in colleges or universities. One person suggested piloting One Health education in religious classrooms because a lot of teaching goes on there from K-12 (NB: makes sense as long as Pope Francis is in charge!). Virtual classrooms were also noted.

Barriers and challenges to piloting and scaling up
The main barrier to incorporating a OH-themed program into K-12 education is constraints posed by the current educational system, including lack of knowledge and understanding on the part of teachers and the public, the need for adequate teacher training, rigid limits posed by established curricula, government objectives, and the requirement for standardized testing.
Also noted were overloaded curricula, lack of adequate resources (validated K-12 curricula, infrastructure, access to the internet and IT, materials such as case studies, activities, textbooks, pedagogical methods and tools), and inertia of current educational systems and their representatives. Many respondents stated that One Health is complex, requires simplification, and concrete and practical examples to make it more easily understood.
Major logistical challenges to scaling-up a K-12 One Health curriculum to a global stage that respondents anticipated were lack of funding and resources (IT, infrastructure, human resources, content, simulation exercises, alternate delivery platforms), constraints posed by current educational systems (different education systems/formats/settings, teacher training, limitations imposed by pre-existing curriculum requirements, need for tailored education to different contexts, underserved areas sustainable funding), and cultural and language differences. One person noted the need to first measure the added value of pilot projects before scaling up.

Who?
The most common educational stakeholder sector that should be represented in developing the concept of a One Health-themed education initiative into a successfully-funded proposal included various members of educational systems (teachers and educators at all levels (including university) of public and private sector, educational/instructional/ curriculum designers, school administrators, teacher associations, teacher training institutions, teachers unions, and educational researchers). Government was also mentioned frequently. Interesting suggestions included church schools, where a great deal of education takes place, parents and students, and publishers of textbooks.
Funding organizations that might support implementation of a One Health-themed education initiative included government sectors (education, development, health), various private foundations (Wellcome Trust, Melinda & Bill Gates Foundation, Soros Foundation, The Josiah Macy Jr. Foundation, Rockefeller Foundation, Skoll Foundation, the Global Fund, the Foundation for International Medical Education and Research), International nongovernmental organizations such as those originating in the EU and the UN, and banks such as the World Bank. Also mentioned were the European Social Fund, The Network: Towards Unity for Health, the European Horizon 2020 Program, and the Global Partnership for Education.

Other comments and suggestions worthy of mention were:
- A One health curriculum has to be content rich and 'not just another vague thing' about relationships and collaboration, and that it needs to address critical problems like climate change, agricultural intensification, comparative medicine, environmental health threats.
- Consider strengthening and using innovative on-line teaching, flipped class room, take advantage of existing educative one health tools (MOOC on one health, environment challenges, etc.), and create new ones.

- The biggest challenge we face in implementing a One Health curriculum at a global stage is the lack of a major driving force in One Health. Although we are trying our best as One Health clusters, we need to have a major support from a so called "Poster Boy", something that will catalyze our efforts.
- One-Health should be a process that start at pre-primary level to change mind-sets, although there should be entry-levels at all phases for those who were not exposed from the start. It will be beneficial if the one-health principles thinking can be incorporated as it relates to different subject streams (e.g. economics, social science, and others).
- We need to understand that we, as individuals, are not quite the center of the Universe and that our actions, even though they may not bring us much benefit/losses, surely can influence everyone around us.
- This is an extremely important project at a very volatile time in our world. Education is the key to supporting and delivering the UN 2030 SDGs.

Strategies for K-12 One Health curriculum innovation

This segment of the conference presented some of the ways that the One Health Education Task Force has considered to utilize One Health concepts in curriculum development for K-12 classroom applications. Feedback from the participants was requested and additional ideas that might be considered for the program and funding proposal were encouraged.

We have explored the following five potential options to consider for our proposal: Curriculum Innovation Grants for Educators, Curriculum Development Workshops for Teachers, Teacher Training Programs, a One Health Education Network, and an On-Line Knowledgebase of One Health Curriculum Materials. We understand that there are different needs among various educational systems and across countries around the world, so the options presented below are not mutually exclusive and we could consider one or any combination of these within the larger project.

i) Curriculum innovation grants for educators

The initial idea that we explored was a program that would offer grants to teachers to develop and implement a One Health focused curriculum at their school that meets specific criteria and objectives set by the One Health Education Task Force. We are attracted to this idea because we understand that teachers themselves know best how to reach their students, what curricular designs work within their institutions and grade levels, and what tools are most effective at reaching outcomes. In addition, by engaging teachers directly and offering opportunities for innovation, we feel that other teachers would be more likely to adopt and share successful methods among themselves, either thru example and their existing networks, or with formal mentoring.

This program would offer *competitive* innovation curriculum development grants to teachers or teams of educators on an annual basis. The focus of this program could be open ended or could involve a changing One Health theme each year to ensure diversity of topics. Applicants would be asked to meet very specific guidelines that target values, skills and knowledge criteria using One Health approaches. These guidelines would be developed by the One Health Education Task Force and would be informed by wider conversations with the One Health global community, including the survey recently conducted. Proposals would need to emphasize interdisciplinary engagement as a fundamental tenet of One Health principles. As time goes by, successful methods and curricula would be shared through the proposed OH Education Network and Knowledgebase described below and would not be limited only to participants in the program.

ii) Curriculum development workshops for teachers

We have received feedback that some teachers would never have the time to devote to curriculum development themselves. Some have also expressed concern that they do not know the subject area well enough to be able to write a curriculum or innovate very effectively along One Health lines. In response, we decided we needed to create an opportunity for motivated teachers to learn more about One Health and receive some direct assistance in creating One Health themed curricula. We are proposing to do this through a series of summer workshops, which would include summer salary for participants. This would be an annual opportunity and could again be open ended or focused on changing themes or topics. Workshops would involve participation by "experts" in One Health, depending on the topics selected, and would also include curriculum development professionals to assist teachers in classroom applications. The workshops would emphasize innovative learning methods that target One Health values, skills and knowledge criteria as described above and would provide an important networking opportunity for sharing and mentoring between teachers and experts.

iii) Teacher training programs

A third concept that we are proposing is to work with teaching training programs already in existence that are interested in building One Health approaches into their training programs. This approach would involve new teachers in the process of curriculum development and could be implemented through specific courses or teaching modules. By working with teaching training programs we would be creating opportunities for innovation from the ground up which may provide greater opportunity for broad integration of One Health values across subjects. In this environment, we would also be in a good position to inculcate One Health skills and knowledge in teachers during a critical period in their own development as educators. This approach would also ensure that appropriate regional programming is being developed that best meet the needs of local education systems and would maximize benefits and outcomes which may not be otherwise adaptable from a more universal, less regional approach. It was suggested that we think about promoting this opportunity to make sure teachers that need it to take advantage of it. This could be done by developing introductory one health presentations and using social media to reach a broad audience. The example of an IVSA program was given where they are "developing a one health presentation to school children on veterinary public health, one health and explaining the diversity and active contribution of vets and medics to the human-animal-environment interface. We plan to distribute it to our member organisations in over 60 countries and translate it to at least 2/3 languages for teachers to use. We hope to use social media to spread the word, to students will promote or present this workshop to communities, to families and then to schools- to encompass student centred learning (Bhavisha Patel)."

iv) One Health education network

The creation of a One Health Education Network will be critical to global adoption of any curriculum innovation that results from this initiative. We feel that it would be very valuable to foster mentorship and sharing among project participants and provide opportunities for others outside the project to benefit from the teaching expertise that develops as a result of this initiative. Over several years this could develop into a robust and supportive cohort of One Health Educators around the globe and provide the best mechanism for achieving Sustainable Development Goals globally through One Health.

The OHE Network would provide a directory of One Health educators, facilitate communication between educators with social networking tools, and facilitate mentorship connections between educators and One Health experts. The network could act as a platform for organizing meetings and presentations, and would facilitate collaboration on future projects. Importantly, the network could become self-sustaining simply through the interest and enthusiasm of the participants and provide longevity to the investment of this project for years to come.

v) On-Line knowledge base of one health curriculum materials

Finally, we want to openly share the products of any of these curriculum development programs as we start a movement and inspire teachers around the world to adopt One Health principles in their teaching. We propose to build an open access technology platform for sharing curriculum that will serve as a repository for products of any grants or workshop programs developed through this initiative. Sharing outwardly to the world would provide an opportunity for feedback and dialogue to improve these products and encourage, in an organic way, the transition of more curriculum to include One Health principles. Over time, this knowledgebase could also link to or include contributions from outside this project and broaden the impact and engagement for One Health themed educational initiatives that furthers our global objective for achieving Sustainable Development Goals through One Health themed education.

Above are the five main programs we have focused on to date and we encourage feedback and input from a broader audience. There are many details to work out, and the scale of these programs is still undetermined. What follows is a summary of the participant suggestions and calls for clarification concerning the strategies presented.

First and foremost we would like to clarify that the scope of this project is intended to be global. While initial implementation of pilot projects may precede full globe reach, the pilot projects would likely include a diversity of sites. The exact structure or timeline has not yet been determined. The different nature of various education systems around the world and even within a country like the US was brought up as a challenge. Within the US, there is a great deal of variation and level of influence between state agencies and the federal government through the Department of Education. Some states may be more receptive than others to the type of curriculum initiative we are proposing. We hoped that the first option which asks for teachers themselves to come forward, would take care of some of this diversity. Teachers would presumably be proposing curriculum development that would work within their own context. The great differences between developed educational systems and developing educational systems will also be a challenge and may require two different efforts or pathways.

Some clarification about who will make up the group of "One Health" experts to participate will be needed, especially since there are no specific well defined criteria for a One Health expert, or any standardized system for accreditation or academic degree existing today. We are specifically look for content experts to provide necessary knowledge and resources, as well as curriculum development experts, and the specific qualifying criteria that defines a participating "expert" still needs to be worked out.

An excellent suggestion was made to consider including parents in grants or workshops to help bridge the resource gap in some low-income schools where parent leaders play an important volunteer role. Engaging with parents may also promote greater acceptance with the community outside the school.

The concept of a "community of practice" approach was mentioned as a model for the knowledgebase as well as the network. One way to do this might be to target a specific group of people involved in middle and high school education and connect them with existing experts

or groups that might have resource materials to provide, such as the OIE. We would very much like these two programs, the knowledgebase and the network, to operate as a community of practice in One Health education. One significant outcome will a One Health education foundational body of work that currently does not exist.

Another mentorship model to consider would be the twinning model, used in the USAID Emerging Pandemic Threats program and others to share between developed and developing educational systems or institutions.

There were a couple of cautionary remarks to conclude this section. First of all, considering the large scope of programs and challenges for implementation, there was some concern about staff time and capacity necessary to follow through with this initiative and a need to establish realistic priorities. We are very aware of this and will be considering these questions as we approach funders and develop a timeline. Lastly, beware of the top down approach being proposed by our group of One Health champions. This will not work without active engagement with K-12 education partners. We have discussed this at length and have been struggling to find the appropriate enthusiastic partners. We welcome any good ideas or introductions to institutions or people that we can draw in to this initiative that will provide the appropriate input. Dr. Lueddeke will provide more detail on our potential partners defined to date.

Funding considerations for a One Health education initiative

This segment of the conference focused on three main funding considerations:

  i)   Linking UN 2030 Sustainable Development Goals to *One Health* education initiatives (10);
  ii) Supporting projects through existing development mechanisms;
  iii) Possible funding sources.

A key argument for project funding decisions was that the One Health concept and approach need to be considered as a lens or filter for shaping global policy and strategy regardless of the SDG goals and targets being evolved and implemented, including K-12+ education (Fig.1).

And, while the Habitat III The New Urban Agenda (11) agreed in October 2016 is a highly commendable achievement, according to a word search, the 19 documents failed to mention terms or explanatory paragraphs/recommendations related as Planet, One Health, Conservation, Animals, Epidemic, Root causes, Overcrowding, Inequities, Automation, Eco footprint, Infectious disease, Non-communicable disease and only singularly cited the words Prevention, Healthy lifestyles, Ageing population, Mental health.

More than 70 % of the world's 9 billion population will be living in cities by 2050 or before. One Health crosses all discipline boundaries, and it is important that the project planners identify and collaborate across existing networks, as shown in Fig. 2.

Consideration to seeking funding from multiple funding sources might also be appropriate (e.g., Bill and Melinda Gates Foundation, UN agencies (e.g., UNDP, UNESCO), Rockefeller Foundation, MacArthur Foundation, the UK Department for International Development, and Welcome Trust). Several avenues will be pursued in the next few months, including making personal contact with potential partners or collaborators.

Figure 1. Linking UN 2030-global goals to K-12 One Health and well-being education
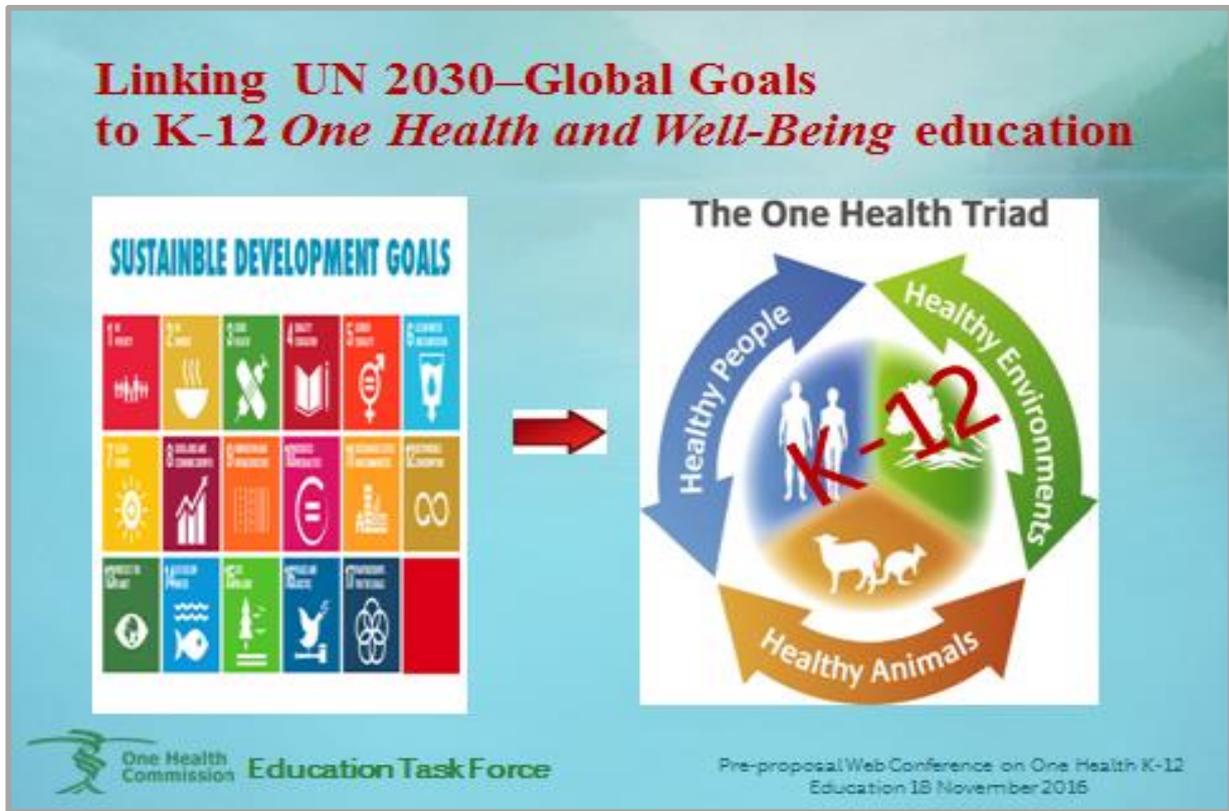
Global Networks: **United Nations** 193 Members States -2 observer States **WHO Collaborating Centers** (>700) **World Bank** Global Learning Development Network (>120 institutions – 80 countries) **The Commonwealth** (52 nations) **The European Union** (27 nations)	**Figure 2.** **Global networks (selected)**

Further to a question about identifying good partners, it is recognised that a traditional top down approach is not likely to work in this situation. An example of behaviour change that worked well in the U.S. in 70s and 80s is recycling, a local, bottom up endeavour. Interestingly, it was young people (children) being inspired by teachers that made the recycling movement happen in the U.S. We should be concerned about strictly advocating a top down approach for K-12 One Health Education. A successful approach has to start more locally, but be guided by national aspirations or goals. Local and national interests should be working in tandem. In the U.S. and the U.K. there has been very little discussion so far about the Sustainability Development Goals. We must draw on expertise locally and find support nationally to enable action groups.

We like to think of the dual concepts of One Health and 'well-being'. One Health is beyond any political or health system. It's really saying here is our planet, a very small planet, and we have got to keep it healthy regardless of how we are living our lives. It is probably the only non-divisive concept that we have right now. The UN development program folks have done a fairly good job with disseminating information. But, if the UN had incorporated One Health a year or so ago, we would be further along.

Meeting the needs of the diverse global community

Although we believe there exists One Health core values, principles and concepts, we recognize that operationalizing One Health in primary and secondary schools must recognize and appreciate educational, cultural and social differences among countries and educational systems. Therefore, no one model or curriculum will fit all situations. How then, can we begin to frame a proposal that honours One Health core values, principles and concepts, but is flexible enough to be adapted for diverse circumstances?

A point well-taken from the survey is that a validated One Health curriculum does not exist. For that reason, any attempt to propose one must include a pilot phase from which one could learn valuable lessons related to adoption, implementation, and evaluation of a curriculum before it could be modified and scaled up in one or more systems. Therefore, a successful proposal will focus on pilot studies in one or more education systems (to be defined), but at the same time, it must include metrics that could be used to judge whether or not here is evidence that scaling up and/or out is feasible and of value.

Various models have been used to pilot educational interventions, even those that encompass One Health, in colleges and universities and in the health workforce. Historically these have been piloted in one or more systems that are not linked, but in the last decade a twinning model has gained interest and acceptance. This model links two or more educational systems that, at its best, involves equal partners that each learn from the other; it can, however, evolve to a mentor-mentee situation whereby one partner assumes most of the responsibility and the other partner(s) assume lesser, more receptive roles. There may be other models of which we are not yet aware, and we look to others to suggest them. Twinning and other models have been implemented at various scales from local to national systems.

Participants seconded the idea of a proposal that takes a twinning approach and starts at the local level, with curricula that are meaningful to local communities and that involve parents, community members and students alike as teachers and learners. It would be instructive to apply twinning between a higher income and a lower income country, as is being done at a university level, and to look for points of alignment and difference. The proposal may want to

consider adopting a term other than 'twinning," which is so closely associated with university-level activities and is, as was pointed out, often interpreted by higher income countries as "the world is here for us to remodel."

Building on responses to the survey, participants suggested that there is a need for concrete yet simple to grasp examples illustrative of One Health. If One Health is ultimately about changing behaviours, previous successful examples of changing public behaviours such as recycling (which was started by teachers and taken home to parents and communities by students) and smoking cessation (for which YouTube videos, cartoons and other popular media presentations have been developed and widely disseminated) might offer valuable lessons for how to accomplish behaviour change, but they must be grounded in One Health principles and guided by local customs and beliefs. A proposal would have to involve social scientists, particularly those with expertise in behaviour change and public health. If messages were meaningful and easy to grasp they could be taken to households with the support of government and international organizations. The first nine months of a child's life is critical to her/his perception of the environment as friendly or hostile, and having a 'village' teach One Health to young children could well establish a 'the environment is friendly' mindset (see the Foundation Vie's 1001 Critical Days of Development, also the First Five Initiative in California). Work on empowering girls is being conducted by the University of Wisconsin in Ghana and could illustrate successful implementation of this approach. A recent teacher-training workshop using student-centred active approaches was very well received by teachers who are used to the 'sage on the stage' approach so common in many countries. And, rather than importing more new material into already packed curricula, a proposal could instead strengthen existing curricula, for example, by supporting teachers to adapt current material using more 'hands-on' learning with the natural world that incorporate ethics of how we view and treat each other, animals and the environment. A third option would be to develop 'scaffolding' lessons that integrate existing curricula across disciplines and grade levels.

Scaling up and out presumes some early measures of success, but the goal of a One Health curriculum is to change behaviours. Because this is a long-term outcome, it cannot be used to judge the success of a One Health project in the short term. One suggestion was the level of involvement of a community could be used as an early indicator of success for a pilot project. Another metric being used in Ghana is the degree to which students who experience the curriculum in schools take that learning home to educate their parents, although the cultural appropriateness of children teaching adults has to be considered. Successful pilot projects would be shared widely, thereby developing a "Community of Practice" that would reflect the common goals of One Health teaching and learning and the richness of its adaptations.

Open panel discussion
In this section we discussed additional questions and received numerous suggestions that are not included in the sections above.

The topic of curriculum design was raised. We purposely do not want to prescribe what any given curriculum would look like, whether that be modules, week-long units, individual lectures or a scaffold of modules across grade levels and across subjects. We want to encourage *innovation* in curriculum design and pedagogy as much as possible and are hoping that educators would develop curricula together to produce integrated learning designs preferably to create modules that fit into an existing science class for example. Programs that cut across courses and grades would be optimal. Incentivizing collaborations and trans-disciplinary team-based curricula was suggested, over didactic 'preaching'. Curricula should incorporate issues

based, inquiry based, problem based, small group based methods that focus on real issues, because our challenges today do cross disciplines.

Another suggestion was made to organize content around broad categories made up of a series of small modules or easy to digest, bite-sized pieces. This can be particularly important where language might be a challenge. The reference was made to experience in Ghana in the One Health and Girls Empowerment program with Junior and Senior High School girls. In those workshops they found that in addition to 'content' that the teachers loved learning about student-centred active teaching approaches that they had never been exposed to. They need to see other ways to teach.

There are likely some other good programs already on the ground that we could learn from. Several examples of these were mentioned including:

- an 8-12 grade curriculum for Veterinary Science and One Health Science in the State of Texas (try contacting Dr. Heather Simmons);
- a new MOOC addressing One Health that will be available through Coursera (https://www.coursera.org/) in Spring 2017;
- a University of Washington "Conservation Biology & Global Health" 3 day curriculum for high school students;
- the California State First Five initiative;
- examples of twinning as a collaborative development and support mechanism (e.g. USAID Emerging Pandemic Threats program).

However we proceed, the idea of piloting programs in different regions was felt to be important along with the willingness to be flexible and respond to community and cultural diversity in different parts of the world.

Some discussion centred on the topic of behaviour change. It will be important to include social scientists on the development team that have expertise in this area. One of our challenges is the goal of changing the mindset. 97% of world health funds are going toward *treatment* of disease and only 3% goes to prevention. This is from a global budget of $7.7 trillion US dollars. Because One Health is all about prevention strategies, initiatives like the GHSA should be interested.

It was suggested that there may be lessons learned from experiences in developing countries with HIV behaviour change programs, particularly how to reach communities.

Several participants stressed that one of the best ways to gain support for a new program and improve the possibility of success is to make sure there is a link with communities beyond the classroom, with the caveat that we need to be sensitive about the cultural appropriateness of kids teaching adults. Another potential ally could be the network of school nurses, a group that is greatly under-utilized and under-appreciated. If appropriately empowered, they could be a valuable asset. In any event we will need good partners in the K-12 system before moving forward since a top down approach will likely not work here.

Some discussion came up on the topic of finding funding for educational initiatives. It was suggested that it might be helpful to look at the portfolios of the various donors (e.g. USAID, DFID, multilateral and regional banks, etc.) to look for compatible interests in education. It can be very challenging to get an innovative, technical assistance grant. Reference was made to experience in a new regional project in West Africa called the *Regional Disease Surveillance Systems Enhancement Project*, a huge World Bank project that handles 15 countries in W Africa with OHAHU and WHO that involved several hundred million dollars. Another suggestion was to explore existing zoonotic disease initiatives, such as PREDICT or the Global Health Security Agenda (GHSA).

Some other potential funding sources mentioned include: Skoll, Ford, Rockefeller, Gates, the Instituyo Alana in Sao Paulo Brazil, African Union/ECOWAS.
In some cases, appealing directly to Ministries of Education or Health might find support for being the first one to institute something truly innovative (e.g. island nations like Fiji and Seychelles).

Conclusion
We assumed that most people attending this conference (10) do support the idea of K-12 One Health Education. Perhaps attendees, like us, are driven by the need to examine what is currently being done (in education) and to postulate what we *need* to be doing differently to prepare future generations. There are some attempts being made globally for One Health education at the graduate and professional education levels. But that is too late to significantly affect behaviours and in still attitudes of open collaboration and interactions. By then young people are already in their academic silos.
We are very concerned about current attitudes toward our human place on the planet. In this conference we have outlined some tangible, programmatic models that could be used in young children and expanded to a global community of practice to improve things for future generations. The UN Sustainable Development Goals are a wonderful target to aim for globally. But there is currently no mechanism to unite and implement them. One Health thinking and acting can do that.
Indeed, One Health is a pathway not only to the UN SDGs and planetary health, but also to Global *Security*. Health and well-being are profoundly embedded in and dependent on global government stabilities. As the last 10-15 years have shown, it can be very difficult to introduce One Health concepts to already established systems. But K-12 children will be our future global leaders. How do we help them understand the severity of what is going on right now in the world? What is restraining us from doing new things like taking One Health education and concepts to young children? We need to change today's mindset/paradigm of using up our global resources without regard for the health and well-being of our planet because future generations will depend on Mother Earth. How do we get individuals, governments and corporate bodies to think more holistically and sustainably about the health and well-being of people, animals and the planet? There is much work to do to make One Health the *default* way of doing business around the world. Children and One Health can be our 'Ray of Hope' for the future.

References
1. Lueddeke G, Kaufman G, Kahn L, Krecek R, Willingham A, Stroud C, et al. Preparing society to create the world we need through 'One Health' education. SEEJPH 2016;6. DOI 10.4119/UNIBI/SEEJPH-2016-122.
2. Lueddeke G, Stroud C. Preparing society to create the world we need through 'One Health' education! (Press Release). One Health Commission. Available at: https://www.onehealthcommission.org/documents/filelibrary/commission_news/press_releases/61016__OH_Education_Press_ReleaseFi_F7644A48F9910.pdf (accessed: March 20, 2017).
3. United Nations. United Nations. Transforming our world: The 2030 agenda for sustainable development. Available at: https://sustainabledevelopment.un.org/post2015/transformingourworld (accessed: March 20, 2017).

4. One Health Commission (OHC). (2017). Mission. Available at: https://www.onehealthcommission.org/en/why_one_health/ohc_mission/ (accessed: March 20, 2017).

5. One Health Initiative (OHI). Mission Statement. Available at: http://www.onehealthinitiative.com/mission.php (accessed: March 20, 2017).

6. The Commonwealth Secretariat (Health and Education Unit). Advancing sustainable social development through lifelong learning and well-being for all. Available at: https://drive.google.com/file/d/0B8wr6920su0aRHlyd0pDOERlajQ/view (accessed: March 20, 2017).

7. One Health Commission. One Health Education Conference. Available at: https://www.onehealthcommission.org/en/eventscalendar/one_health_education_online_conference/ (accessed: March 20, 2017).

8. Lueddeke G. Global Population Health and Well-Being in the 21st Century: Toward New Paradigms, Policy and Practice. New York: Springer Publication; 2016. Available at: http://www.springerpub.com/global-population-health-and-well-being-in-the-21st-century-toward-new-paradigms-policy-and-practice.html (accessed: March 20, 2017).

9. WWF International. Living Planet Report 2014. Available at: https://www.wwf.or.jp/activities/lib/lpr/WWF_LPR_2014.pdf (accessed: March 20, 2017).

10. Lueddeke G. The UN-2030 sustainable development goals and the One Health concept: a case for synergistic collaboration towards a common cause. World Medicine Journal, vol. 62, 2016: 162-167. Available at: http://lab.arstubiedriba.lv/WMJ/vol62/december-2016/#page=44 (accessed: March 20, 2017).

11. UN News Centre. HABITAT III: UN conference agrees new urban development agenda creating sustainable, equitable cities for all. Available at: http://www.un.org/apps/news/story.asp?NewsID=55360#.WO3xddQrJkg (accessed: March 20, 2017).

APPENDIX I – Participants in the One Health Education Conference and Survey *(respondents to the survey who identified themselves included)*

James Akpablie
Claire B. Andreasen, Iowa State University, College of Veterinary Medicine
Olutayo Babalobi, One Health Nigeria
Christopher Birt
Isabelle Bolon
Bonnie Buntain, University of Arizona, School of Veterinary Medicine
Bill Burdick
Peter Cowen, North Carolina State University
Stephen Dorey, Commonwealth Secretariat, Health and Education Unit
Eliudi Eliakimu
Nirmal Kumar Ganguly, National Institute of Immunology, Department of Biotechnology, India
Julie Gerland, Noble Institution for Environmental Peace, Chief UN Representative
Aja Godwin
Ralf Graves
Michael Huang
Lai Jiang, Institute of Tropical Medicine, Belgium
Bruce Kaplan, One Health Initiative
Getnet Mitike Kassie
Gretchen Kaufman, One Health Education Task Force
Ulrich Laaser
Sultana Ladhani, Commonwealth Secretariat
Zohar Lederman, National University Singapore
Joann Lindenmayer, One Health Commission
Jill Lueddeke
George Lueddeke, One Health Education Task Force
Pamela Luna
Donald Noah, One Health Center, Director
Martha Nowak, Kansas State University, Olathe
Chris Olsen, University of Wisconsin
Olajide Olutayo
Amina Osman, Commonwealth Secretariat, Health and Education Unit
Steven A. Osofsky, Cornell University
Bhavisha Patel
Nikola Piesinger, Mission Rabies, UK, Education Officer
Kristen Pogreba-Brown
Peter Rabinowitz, University of Washington
Vickie Ramirez, University of Washington
Ralph Richardson, Kansas State University, Olathe, Dean/CEO
Raphael Ruiz De Castaneda, Institute of Global Health, OH Unit, Geneva
Laura Schoenle
Richard Seifman
Sara Stone
Alexandru Supeanu, One Health Romania

APPENDIX II – Survey Instrument

The following Survey was conducted by the One Health Education Task Force between October 16, 2016 and December 10, 2016 utilizing the Survey Monkey ® web based platform.

Introduction: The goal of this survey is to collect views on the importance of One Health in preparation for an online pre-proposal conference scheduled for mid-November. Survey feedback will help us define the parameters and design of a global One Health-themed educational funding initiative, spearheaded by the One Health Commission in association with the One Health Initiative. The proposed project focuses on the development and support of One Health (and well-being) curriculum materials, involving primarily K-12* teaching staff and education providers. The survey will help to identify ways of addressing challenges to successfully implement a number of pilot projects on a global scale. Subsequent educational initiatives will address post-secondary and professional education.

The survey will take approximately 20 minutes to complete.

The survey employs the One Health Commission definition of One Health: **"One Health is the collaborative effort of multiple health science professions, together with their related disciplines and institutions – working locally, nationally, and globally – to attain optimal health for people, domestic animals, wildlife, plants, and our environment."**

*"K-12" is defined as organized pre-primary through secondary school education. We acknowledge that this is not uniform terminology around the world, but will use this term for convenience.

Survey Questions

Objective 1: ***Identifying complex issues/examples that can be used to address the drivers of One Health challenges and can lead to sustainable solutions.***

1) List 5 words that immediately come to mind when you think of *One Health* (open question):
2) Please rank the following types of sustainability from 1-5 in terms of their importance to One Health (1=most important and 5=least important)
   a. Ecological
   b. Economic
   c. Cultural/Social
   d. Ethical
   e. Justicial (of or relating to justice, as opposed to judicial)
3) List 3-5 One Health challenges that could be used to illustrate the need for a One Health approach. Include no more than one zoonotic disease.
4) Please choose what you believe are the 5 most important contributing factors to the development of One Health challenges (not limited to disease transmission) that should be considered in developing preventive policies or sustainable solutions or those challenges:
   a) Lack of knowledge/understanding
   b) Lack of methods and tools to investigate complex problems
   c) Lack of uniform standards for information management and sharing
   d) Compartmentalization of health services and policies
   e) Lack of funding streams that encourage collaboration and provide support for One Health initiatives
   f) Overemphasis of treatment sef individuals (human and animal) at the expense of preventive medicine and population health

18

g) Overemphasis of human health at the expense of animal and environmental health
h) Human population growth and development
i) Poverty, distribution of wealth, inequity
j) Political systems that support individual/corporate interests above all else
k) Globalization in the absence of global standards of practice
l) Short-term decision/policy horizons
m) Over-exploitation of natural resources
n) Tribalism
o) Climate change
p) Other- open ended

Objective 2: Meeting the UN Sustainable Development Goals thru One Health-themed education (**http://www.un.org/sustainable-deevelopment-goals/).**

5) How well do you think a One Health-themed K-12 education program relates to each of the following SDGs (1=not at all related and 5=highly related)?
   a) End poverty in all its forms everywhere
   b) End hunger, achieve food security and improved nutrition and promote sustainable agriculture
   c) Ensure health lives and promote well-being for all at all ages
   d) Insure equitable and inclusive quality education and promote lifelong learning opportunities for all
   e) Achieve gender equality and empower all women and girls
   f) Ensure availability and sustainable management of water and sanitation for all
   g) Ensure access to affordable, reliable, sustainable and modern energy for all
   h) Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
   i) Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
   j) Reduce inequality within and among countries
   k) Make cities and human settlements inclusive, safe, resilient and sustainable
   l) Ensure sustainable consumption and production patterns
   m) Take urgent action to combat climate change and its impacts
   n) Conserve and sustainably use the oceans, seas and marine resources for sustainable development
   o) Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification and halt and reverse land degradation and halt biodiversity loss
   p) Promote peaceful and inclusive societies for sustainable development, provide access to justice for all, and build effective and accountable, inclusive institutions at all levels
   q) Strengthen the means of implementation and revitalize the global partnership for sustainable development
6) Are there other sustainability goals that you think should be included (open-ended):

Objective 3: Identifying values and principles that underlie a global One Health approach towards health and well-being for the planet.

7) Which one of the following graphical representations best captures the values and principles of One Health?
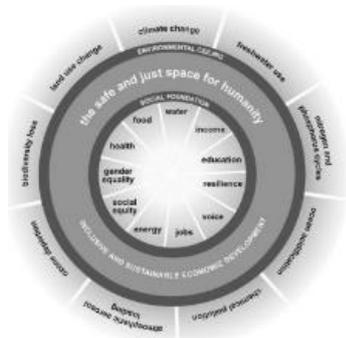
a) Sustainability donut   b) Umbrella   c) Triad

d) Venn diagram   e) Concentric circles

f) none of the representations are satisfactory

8) Which of the following <u>values</u> do you think are essential to the application of One Health? (please select all that apply)

- Balance
- Community
- Compassion
- Competence
- Compromise
- Cooperation
- Diversity/Biodiversity
- Empathy
- Experience
- Freedom

- Growth
- Humility
- Integrity
- Justice/Fairness
- Leadership
- Mindfulness
- Reason
- Resilience
- Respect
- Responsibility

- Rigor
- Self-awareness
- Sustainability
- Synergy
- Tolerance
- Transparency
- Understanding
- Vision
- Other (open ended)

9) To what degree do you agree with each of the following statements as it relates to One Health, where 1=strongly disagree and 5=strongly agree?
   a) When you optimize health for one species, health for others is marginalized or eliminated.
   b) One Health should be practiced so that there is no net (ecosystem) loss of biological diversity.
   c) The health of humans, other animal species and plants cannot be separated.

    d) One Health recognizes the intrinsic value of life on earth (plants, animals, microbes) regardless of a direct benefit to humans.

    e) "Environment" includes natural and built environments.

    f) One Health embraces the value of social interaction as a critical component of health and well-being.

    g) Humans have a moral imperative to address One Health challenges.

    h) Ecological, economic, social/cultural, ethical and justicial sustainability are <u>equally</u> important for One Health.

    i) The World Health Organization defines "health" as "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity." This definition also applies to other animals and ecosystems.

    j) Other (open ended).

Objective 4: Designing a global One Health-themed K-12 educational program that supports innovation by educators and learners.

10) In your experience, to what extent are students currently exposed to concepts related to One Health (including well-being) where 1=not at all exposed and 5=highly exposed?

    a) Pre-primary education

    b) Primary education
       Secondary education

    c) College and university education

    d) Adult education

    e) Other (open ended)

11) How important is it that students are introduced to One Health concepts in the educational curriculum at the following educational levels, where 1=not at all important and 5=highly important?

    a) Pre-primary school

    b) Primary School

    c) Middle School

    d) High School

12) In what types of schools would you pilot a One Health-themed curriculum, understanding that not all school types are found in every country (please select all that apply)?

    a) Publicly-funded schools

    b) Privately-funded schools

    c) Magnet schools

    d) Charter schools

    e) Independent schools

    f) Home school networks

    g) Extra-curricular education (after school)

    h) Summer school or camps

    i) Colleges or universities

    j) Other (open ended)

13) What broad-based skills should students learn through a One Health- themed educational program (please select any that apply)?

    a) Collaboration

    b) Communication to diverse audiences

    c) Concept mapping

    d) Conservation

    e) Experimental design/methods/inquiry
    f) Goal-setting
    g) Interdisciplinary thinking
    h) Leadership
    i) Problem-solving
    j) Systems thinking
    k) Team-building
    l) Other (open ended)

14) To what extent should students be exposed to the following concepts in a One Health-themed educational program, where 1=not at all exposed and 5=highly exposed?
    a) Role of natural and built environments in human and animal health and well-being
    b) Respect for natural systems and human responsibility for planetary health
    c) The connection between well-being and mental/physical health
    d) Personal responsibility – how individual actions impact One Health
    e) Corporate, political and societal responsibility – how their actions impact One Health
    f) Climate change and health of the planet
    g) Environmental contexts of One Health issues
    h) Staying healthy and making good choices for the environment
    i) "Cradle-to-grave" thinking
    j) Other (open ended)

15) In your opinion, what are 3 main barriers to incorporating a One Health-themed program in K-12 education in your country (open ended)?

16) What do you believe should be some long term outcomes (how might it change the knowledge, understanding, attitudes or behaviors of students) of a One Health-themed curriculum (open ended)?

Objective 5: Identifying challenges that must be addressed for a proposal to be funded

17) What educational stakeholder sectors (e.g. state, private, other) should be represented in developing the concept of a One Health-themed education initiative into a successfully-funded proposal (open ended)?

18) Please suggest up to 3 funding organizations that might support implementation of a One Health -themed education initiative (open ended).

19) Please list up to 3 major logistical challenges to scaling up a K-12 One Health curriculum to a global stage (open ended)?

20) Please provide any other comments or suggestions (open ended).

_____