

# A Focus on Methodology: A Mixed-Methods Approach to Conduct a Comprehensive Evaluation of the Need for One Health Education for Medical and Veterinary Students in the Context of COVID-19

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## ABSTRACT

**BACKGROUND:** The collaboration of health professionals across the interface of human, animal and environmental health, as embodied by the One Health concept (OH), is increasingly recognised as crucial for tackling diseases such as Ebola and COVID-19. This study was conducted prior to the COVID-19 pandemic, but in light of the current pandemic, the outcomes of this study highlight the need for educating Medical (MD) and Veterinary (DVM) students on the principles of OH. The purpose of this study was to determine the need for Interprofessional Education (IPE) initiatives that would familiarise MD and DVM students with the principles of OH, crucial to dissolving the siloes that have historically deterred collaboration.

**METHOD:** We used a sequential explanatory Methods Research (MMR) approach design to evaluate the readiness of 428 students consisting of MD, DVM and dual degree Master of Public Health (MPH) students (MD/MPH, DVM/MPH) for IPE, as well as to obtain faculty perspectives across these disciplines, on the need for curricula inclusion of IPE and OH. Two methods of data collection were employed: A survey and 2 focus groups interviews.

**RESULTS:** The use of an MMR approach allowed us to comprehensively evaluate the need for OH education through the lenses of the students and faculty using a joint display that facilitated data integration and evaluation. Overall, the dual degree students had the greatest readiness for IPE, and MD students the lowest level of readiness for shared learning. The dual degree students had the most accurate understanding of OH competencies that consider the impacts of climate change, food security, antimicrobial resistance, health policy formation and zoonoses occurrence on human health. Themes derived from the focus group interviews revealed that faculty perceived OH education as crucial for preparing MD and DVM students for practice.

**CONCLUSION:** The comprehensive assessment of the student and faculty perspectives, obtained using an MMR approach, illustrated that the incorporation of OH competencies within the MD and DVM curricula are crucial for preparing students for practice in the global environment. The dual degree pathway provides insight into how OH can be successfully incorporated within the curricula of these programmes.

**KEYWORDS:** COVID-19, Mixed Methods, Interprofessional Education, medical, veterinary, One Health

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## Introduction

Settele et al<sup>1</sup> explain 'A single species is responsible for the COVID-19 pandemic – us. This is the human hand in pandemic emergence'. (p. 1). Current approaches to address pandemics such as SARS-CoV-2, are to provide a band aid once they occur, relying on vaccine deployment and therapeutics towards mitigating pandemic spread. What is required to prevent disease occurrence, is a focussed transdisciplinary approach to understand and address the underlying social, behavioural, economic and environmental factors driving zoonoses emergence.<sup>2</sup> The conceptual framework of OH, representing the interconnection between animal health, environmental health and human health, provides such a strategy for enabling a collaborative public health response for tackling global health

emergencies. On September 5<sup>th</sup>, 2021, the G20 Health Ministers recognised the urgency to operationalise a OH approach at all levels of governance, towards preventing and controlling the occurrence of future pandemics of zoonotic origin.<sup>3</sup>

Osterhaus et al<sup>2</sup> advocates that, as the source of all key global health issues have their origins at the human-animal-environmental interface, the 'best solution' (p. 2) would be for health professionals and policy-makers to adopt a transdisciplinary OH approach in attending to these threats in an inter-professional manner. For example, policies to restrict the global wildlife trade can intercept the spill-over of agents such as SARS-CoV into humans, with implications for preventing the occurrence of pandemics such as COVID-19. Additionally,



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**Table 1.** Originality of the research in closing existing gaps.

WHAT IS KNOWN	ORIGINALITY OF THE STUDY: CLOSING GAPS IN THE LITERATURE
MD students are the least ready to engage in IPE amongst the health disciplines.	The readiness of DVM and dual degree students for IPE.
<ul style="list-style-type: none"> <li>MD students are unaware of the impact of zoonoses on human health. consistent with the literature that MDs fail to consider zoonoses on their differential patient list.<sup>6</sup></li> <li>DVM students appear unaware of the role of social, cultural factors on zoonoses emergence.</li> <li>MD &amp; DVM students are limited in their knowledge about the impact of environmental health on their patients..but we do not know the specific nature of these gaps.<sup>7</sup></li> </ul>	<ul style="list-style-type: none"> <li>Use of theory to explain why MD students have low IPE readiness</li> <li>To explain stakeholder (faculty/ administrator) perspectives on the opportunities and challenges for developing IPE, OH and the need for the intervention.</li> </ul>
Suggestions by educators for incorporating OH in medical curricula and including DVM students alongside MDs to enhance MD students knowledge about the impact of diseases of animal origin on human health. <sup>7</sup>	<ul style="list-style-type: none"> <li>Few studies on how MDs perceive the relevance of OH.</li> <li>No studies that compare the readiness of dual degree MPH students for IPE to single degree MD and DVM students as an indicator of their readiness for collaborative practice.</li> </ul>
Challenges to implement IPE and get administrative support in the absence of accreditation mandates.	<ul style="list-style-type: none"> <li>No studies that provide insight into whether the dual degree programme provides methods as to how known challenges to developing IPE /OH can be overcome.</li> <li>No studies that provide the comparative perspective of faculty/ administrators across 3 disciplines for identifying opportunities and barriers for developing IPE/OH</li> </ul>

food and water security can be maintained using OH approaches as trends in agricultural and aquaculture practices are responsible for transmission of antimicrobial resistant organisms to humans.<sup>2</sup> Surveillance in animal species for the genomic similarities that occur in human cases of SARS-CoV is essential to identify the viral origin and to prevent the occurrence of similar diseases as well as to predict future occurrences.

Interprofessional collaboration that executes a OH approach is necessary to prevent and control emerging diseases of animal origin impacting human health such as COVID-19. It is crucial that medical, veterinary, environmental and public health practitioners appreciate their environmental and social responsibilities and the long-term impact of their actions on protecting the public health. It is the collaborative effort of these groups in driving policy changes that protect nature, that is necessary for preventing the occurrence of future pandemics.<sup>1</sup> IPE which promotes shared learning between health professionals<sup>4</sup> is thus crucial for these groups to understand the key expertise and roles other medical professional groups have to play in drafting a suitable response to pandemic emergences of zoonotic origin.

Osterhaus et al<sup>2</sup> described the urgent need to dissolve the siloes long established between animal health and human health, as echoed by Hall.<sup>5</sup> To promote interprofessional collaboration requires exposing medical and veterinary graduates to the principles of OH. The implementation of IPE, more specifically shared courses that familiarise MD and DVM students with the principles of One Health, is essential to prepare these groups to prevent and mitigate the effects of infectious diseases on the public health. The development of such structured IPE initiative between MD and DVM students, currently not a requirement by the accrediting agencies of either

group, requires a comprehensive analysis of the need for curricula inclusion of OH and the factors required for informing its design. A Mixed Methods Research (MMR) approach was selected to achieve our research objective as it strengthens validity and reliability of research findings through the use of data triangulation. MMR approaches allow for the collection of both qualitative and quantitative data in a single study, enabling us to obtain a comprehensive perspectives on the need for curricula inclusion of OH within the MD and DVM curricula of one institution, drawing on insights both from students and faculty members.

The MMR approach thus coupled a quantitative evaluation of the students' readiness for IPE and understanding about the importance of OH to practice, with the qualitative faculty perspectives on the need for IPE and OH portrayed using a joint display design. This approach allowed us to further close gaps in the existing literature as it pertains to the readiness of MD and DVM students for IPE, by simultaneously drawing on the faculty perspectives for informing the development of these initiatives. These gaps, found as the result of a rigorous literature review, are depicted in Table 1.<sup>6,7</sup>

The aims of the study were as follows:

1. To determine the differences in readiness scores for IPE in the curricula between the MD, DVM and Dual degree MD MPH and DVM MPH programmes (QUAN aim)
2. Explain the rationale for the differences in student readiness across the disciplines and their responses about the importance of OH (Mixed Methods aim)
3. Explore the faculty perspectives on the need for OH incorporation in the curricula of the MD and DVM programmes (Qual aim)

While quantitative methods enabled us to quantify student readiness for IPE, qualitative data provide us with in-depth insight on the rationale for student readiness for IPE and perceptions on the relevance of One Health. We share the opinion of Fetters<sup>8</sup> who aptly describes a mixed methods approach as enabling different aspects of a phenomenon to be explored that allows an understanding of the ‘whole greater than the sum of the individual parts’ (p. 263). In this paper we show how combining data from both phases provided a nuanced understanding of the factors that influence the readiness scores of students across the programmes for IPE, and their perceptions about the relevance of One Health than could have been done by using one methodology alone. Importantly, Guetterman et al<sup>9</sup> discussed the lack of innovative methods in the health sciences, specifically joint displays that enhance the value of data integration for analysis of the research findings. In this paper, we illustrate how the use of a joint display can be effectively used to portray the contributions of integrating data.

As Lavelle et al<sup>10</sup> argued, conventional singular approaches to research teaching and learning issues in medical education have limited the ability to provide solutions or to extend the theoretical frameworks that guide teaching and learning. Lavelle et al<sup>10</sup> stated that mixed methods designs allow a ‘layered’ (p. 273) approach to assessment of the different strata of factors (social, personal, delivery methods, institutional, autobiographical) that may impact student readiness for learning.

### Theoretical Frameworks

We used 2 theories as frameworks to explain the findings of this study.<sup>11</sup> The structuralist lens of Role theory<sup>12</sup> was used to explain how the student’s perceptions of their future professional roles as physicians, veterinarians or public health practitioners, influenced by the culture of their discipline, may explain the differences in readiness for IPE and their perceived importance of the OH concept. The Theory Based Stakeholder Evaluation (TSE)<sup>13</sup> model was used as an analytical framework for the focus group interviews with faculty. Gaps exist in the literature on the use of theoretical underpinnings to explain the stakeholder perspectives on the development of OH initiatives.

Intervention theories (programme theories) represent assumptions about how an intervention (programme) will alter (positively or negatively) the current institutional situation regarding the issue being addressed.<sup>13</sup> The intervention theory used in the TSE,<sup>13</sup> consists of 3 components: situation theory, causal theory and normative theory. Situation theory in this study describes the faculty and administrator participants’ assessment of the need for OH in the curriculum. Normative theory describes participants’ views of the opportunities presented with the development of OH. Finally, causal theory is used to describe the participants’ views of the challenges to developing the concept of OH in the curricula.

The purpose of this study was to provide insights, necessary for planning a successful introduction of OH into the MD and

DVM curricula. Based on TSE, this then acted as a basis to generate information about (1) the institutional context and needs of the medical school pertaining to student readiness for IPE for familiarising them with the principles of OH (2) normative insights on the opportunities IPE and OH interventions could bring and (3) causes of problems of low readiness and how these can be eliminated through IPE interventions.

### Methods

The research was conducted at a private University based offshore in the Caribbean that offers programmes such as the Doctor of Medicine (MD), Doctor of Veterinary Medicine (DVM), Master of Public Health (MPH) and an Arts and Sciences programme. The University caters mainly to North American students. The DVM programme is accredited by the American Veterinary Medical Association (AVMA) and the Royal College of Veterinary Surgeons (RCVS) and the MPH by the US Council on Education for Public Health (CEPH). The MD programme is accredited by many State level boards within the US and students must undertake the qualifying examination for medicine to obtain residencies at North American affiliate schools.

A sequential explanatory QUAN → qual Mixed Methods design was used which involved the collection and prioritisation of quantitative data followed by qualitative data. In the quantitative phase, a survey was conducted from October to November 2018, that included the Readiness for Interprofessional Learning Scale (RIPLS).<sup>14</sup> The version of the RIPLS<sup>14</sup> used for the purpose of this research consisted of 19 items that assess student readiness for IPE within 4 subscales: Teamwork, Negative Professional Identity, Positive Professional Identity and Roles and Responsibilities. Data were collected in Qualtrics over a 6 weeks’ period and analysed using SPSS version 24. The RIPLS was piloted with my EdD supervisor, a statistician, Chair of the Information Technology Department, an MD graduate, a DVM student, and a dual degree MD MPH and DVM MPH student.<sup>11</sup> No problems were reported as arising from this pilot as everyone interpreted the questions as relevant to their own programmes as health professionals. For example for item 17, ‘the function of nurses and therapists is mainly to provide support for doctors’, veterinary students assumed this was in reference to the working relationship between veterinarians and veterinary nurses. All piloted data were removed from the survey before conducting the final study. A detailed analysis of the survey results can be found in a previously published paper by Roopnarine and Boeren.<sup>15</sup> The survey also included 2 open-ended questions to obtain students understanding about the OH concept and its relevance to clinical practice.<sup>16</sup> Demographic information as well as prior public health experience was also collected from the participants.<sup>15</sup>

The qualitative phase of the study occurred in November 2018 and consisted of 2 focus group interviews with faculty

across the MD, DVM and MPH programmes evaluating the student data to determine the institutional needs, opportunities and challenges for developing IPE that includes OH.<sup>17</sup> Thematic analysis as described by Braun and Clarke<sup>18</sup> was conducted to elicit the key themes emerging from the data. Details of the findings are described in the published article by Roopnarine and Regan.<sup>17</sup>

The implementation matrix<sup>19</sup> details the data collection and analysis used in this study and is depicted in Table 2 below. Table 3 depicts the overall plan for the integration of the data.

A total of 864 students at the selected university who had completed courses in infectious diseases relevant to understanding the concept of OH were invited to participate. The latter consisted of: 598 MD, 99 DVM, 145 MD MPH and 22 DVM MPH students. The research participants representing those agreeing to participate consisted of 237 out of 598 (39.6%) MD students and 78 out of 99 (78.7%) DVM students. A total of 94 out of 145 (62.2%) dual degree MD MPH and 19 out of 22 (86.3%) DVM MPH students at the same university participated in the study, as they undertook a core course in OH and experience IPE throughout the MPH programme. All students who belonged to the research population defined by the researchers were invited for participation in a survey.

The primary inclusion criteria for the faculty focus group participants were involvement in teaching courses relevant to IPE and OH or being senior administrators of the School of Medicine (SOM) and School of Veterinary Medicine (SVM). Based on this, 13 faculty members were identified across all the programmes of which 2 opted out. The Institutional Research Board (IRB) for the participating institution was also concerned about how veterinary faculty would be selected without bias as many are colleagues in the department of the primary investigator conducting the focus groups interviews. To address the issue of selection bias, my Department Chair was required to select veterinary faculty for participation in this study. The Curriculum Chair of the MD programme identified appropriate faculty willing to participate in the study. Two focus groups consisting of eleven faculty in total, across the MD, DVM and MPH programmes participated in the study. Focus group 1 consisted of 6 participants, that included 2 DVM faculty members and 2 senior faculty in the Department of Public Health and Preventive Medicine (DPHPM) which offers the MPH programme. The fifth faculty member was stationed in the MD programme. The sixth and final participant is a key administrator. Many of these faculty members hold adjunct positions in the graduate school where they are involved in research as well as holding dual positions in one or other of the programmes discussed in this study. Focus group 2 consisted of 5 faculty. One participant is in the MD programme. Another participant is a graduate MD MPH and one of the faculty advisers for the American Medical Students Association (AMSA). Three other faculty members are in the DVM programme.

Charts that depicted the students' agreement and disagreement to the survey responses<sup>15</sup> and their definitions on OH<sup>16</sup> were presented to the faculty focus groups. The primary researcher had prepared semi-structured focus group questions described in the earlier referenced manuscript<sup>17</sup> that discusses the analysis and results of the faculty focus groups sessions. In order to address the clear biases that the faculty would have had regarding the need for OH education – as faculty recruited for the study were those involved in courses pertaining to IPE or OH – the primary investigator was aware that there would be potential biases in casting their perspectives on the institutional needs for OH. To address this, the primary researcher deliberately sought to create heterogeneous focus groups involving faculty across the MD, DVM and MPH programmes, to obtain the diverse perspectives of faculty across the disciplines in active discussion.<sup>20</sup>

Onwuegbuzie and Johnson<sup>21</sup> provided the framework for assuring the validity of the overall MMR design used in this study. The entire student population who met the inclusion criteria for the first phase of the study were invited to participate. Sample integration legitimization was addressed whereby a purposeful sample was used allowing the outcomes of the phase involving the student survey to be augmented through the insight of the faculty in the second phase. Peer review involved an assessment of my interpretation by the second author, my doctoral supervisor, to verify my interpretation of the faculty responses. This was done to balance my own views and that of my respondents. Conversion legitimization involved quantization of data (counting themes; word count; prior public health responses made numeric) but with minimal transformation done because of risks associated with problems legitimising these conversions. Paradigmatic legitimization involved analysing each phase of the study and then both phases for integration and drawing of inferences.

### Ethical Considerations

Approval for this research was given by the participating University's Institutional Research Board (IRB). The Participant information and consent forms were emailed to both the students and the faculty invited to participate in the study, to familiarise them with the expectations of their participation in the study. The student consent form was embedded within the survey on the Qualtrics platform, which enabled the respondents to read the form and provide their informed consent indicating their agreement to participate in the survey by selecting yes or no. Written consent for the focus groups was obtained by the faculty that participated, prior to beginning the focus groups sessions, which were conducted in person.

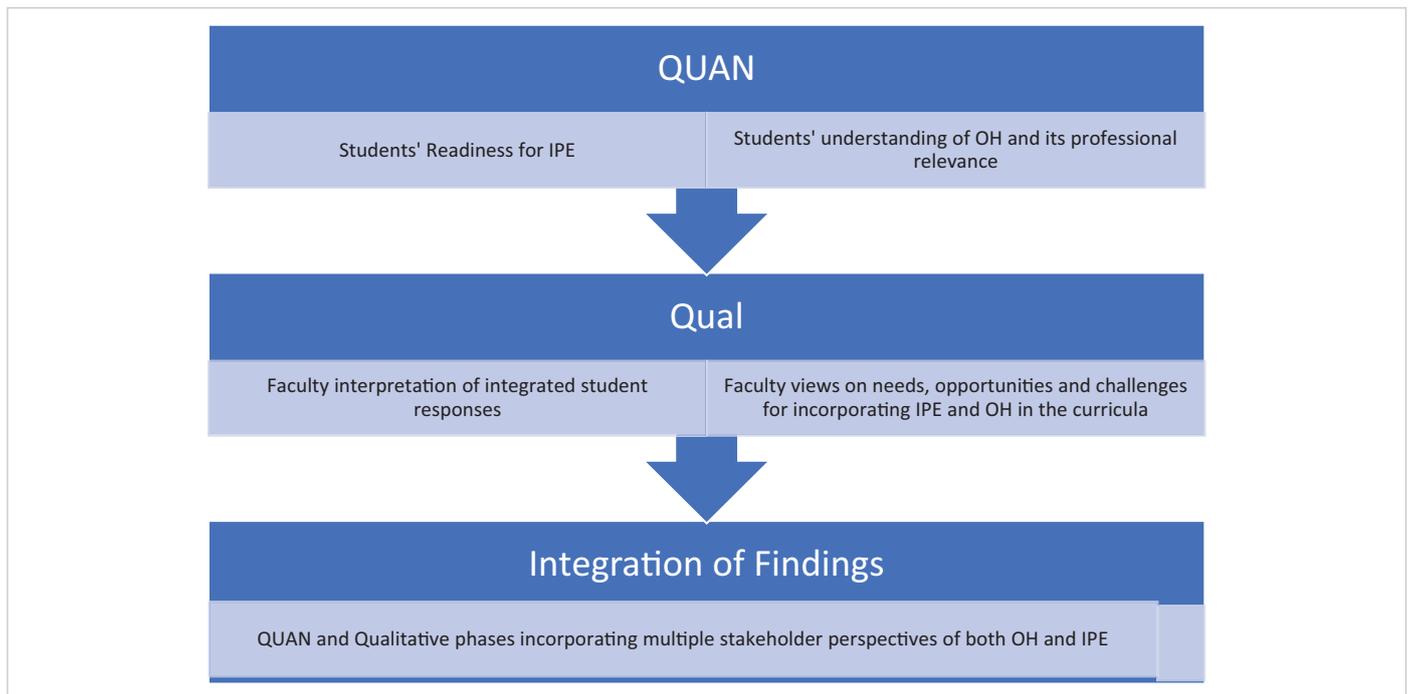
### Mixed Methods Integration and the Joint Display

Presentation of results in this study followed an integrative approach as described by Fetters and Molina-Azorin.<sup>22</sup> Quantitative data provided insights into the differences in readiness for IPE between students in different programmes. The analysis of open-ended statements on the relevance of OH

**Table 2.** Implementation matrix.

STRATEGY	SAMPLE	GOAL/AIM	ANALYSIS	POINT OF INTEGRATION
RIPLS SURVEY	Students	Determine Readiness for IPE	ANOVA, <i>t</i> -tests, appropriate non-parametric tests	Analysis concurrent with that of the qualitative data for informing the focus group and interview discussions
OPEN QUESTIONS	Students	Assess OH knowledge	Thematic analysis	Analysis concurrent with that of the quantitative data for informing the focus group and interview discussions
FOCUS GROUPS	Faculty	Faculty evaluation of RIPLS scores and opportunities and barriers for developing IPE that includes OH	Thematic analysis	Qualitative faculty interpretation of Quantitative student responses and use to create a vision based on identified needs

**Table 3.** Plan for integration of the data.



led to the themes that emerged across the MD, DVM and dual degree programmes.<sup>16</sup> The qualitative focus group interviews allowed us to understand why these differences occurred as faculty explained that differences in accreditation mandates and curricula requirements influenced the differences across the programmes in IPE readiness as well as perceived relevance of OH to clinical practice.<sup>17</sup>

**Results**

Overall, 428 students responded to the survey question asking them to affirm or negate their familiarity with the term One Health. Of 428 students, 322 said they were familiar with the term and 106 said they were not. A total of 364 students across the MD, DVM and dual degree MPH programmes completed all of the RIPLS questions. Of these, 265 students completed the question requiring them to define the concept of OH, while 273 completed the question requiring them to define the

relevance of the concept. The joint display depicted in Table 4 below shows how the results of the survey<sup>15</sup> were integrated with those of the qualitative data.

The results of the RIPLS scores demonstrated the greater readiness of the DVM MPH students to other groups for IPE which was consistent with their more comprehensive understanding of the concept of OH and its relevance.<sup>15</sup> The DVM MPH students were able to appreciate the relevance of OH in policy development, zoonoses prevention and the role of environmental, specifically climatic factors on the public health and their role in mitigating these effects.<sup>16</sup>

Faculty analysis of the RIPLS scores and the focus group data supported these findings and provided an explanation as to why these differences occurred. The DVM programme promotes OH unlike the MD programme, and DVM students are aware of their role in protecting the public health from diseases of animal origin. Combining an MPH with the DVM provides

**Table 4.** Joint Display relating the findings of the RIPLS to the Focus groups data.

PROGRAMME	QUAN	QUAL	INTEGRATION	
	*RIPLS SCORE	RIPLS OPEN Q	FG/INTERVIEW	MMR ANALYSIS
<i>Total Score</i>				
DVM MPH MD DVM MD MPH	71.12 67.84 69.25 69.2	DVM MPH recognised the importance of human, animal and environmental health; Zoonoses; Policy; key human health issues missed by other groups. MD lowest scores overall and focus on human health mainly	DVM promotes OH. MPH incorporates gaps of MD and DVM programmes and is IPE. MD students the least ready for IPE and lack understanding of OH	The overall RIPLS scores [QUAN] were highest for the DVM MPH students indicating the highest level of readiness for IPE. Most accurate understanding of all components relevant to OH. This was supported by the [QUAL] findings where Faculty discussed programme of enrolment impacted student attitudes to IPE and OH
<i>Positive Professional Identity</i>				
DVM MPH MD DVM MD MPH DVM MPH MD DVM MD MPH	17.29 15.42 16.02 16.62 Teamwork 40.47 37.56 39.65 39.57	DVM MPH, MD MPH perceived the importance of collaboration and other sectors to their practice MD focus was on human health and collaboration with human health professionals	Lack of accreditation mandate for IPE and OH in MD. Lack of importance placed by interviewee on IPE with DVM. MD MPH higher scores than MD for Positive Identity and Teamwork demonstrating the importance of IPE as the MPH in their greater readiness for IPE	Focus group/interview results [QUAL] on the negative attitude of MD students to OH and lack of involvement in OH clinics support lowest Teamwork and Positive Identity scores for MD [QUAN]
DVM MPH MD DVM MD MPH	<i>Items 17-19</i> 17: MD 3.42 DVM 3.47 MD MPH 3.70 & DVM MPH 3.71 18: MD 3.73; DVM;4.06; MD MPH 3.84; DVM MPH: 3.65 19: MD: 2.66; DVM: 2.75 MD MPH; 3.09; DVM MPH; 2.76	For the MD students, human health was a significant theme identified for them regarding their roles. These items (17-19), previously located within the Roles subscale, may indicate the students lack awareness of their roles as they have little clinical experience which will be offered in their final years of the programme.	Faculty observed MD students were open to IPE and OH	The overall RIPLS scores for the MDs demonstrated their willingness for IPE and OH but the insights provided by faculty showed this was not realised in practice as it was not an indicator for accreditation of their programme
DVM MPH MD DVM MD MPH	<i>Negative Professional identity</i> 12.47 11.33 12.14 12.41	All groups supported the idea of collaboration, but the MD students were the most focussed on the aspect of human health within the concept of OH	Faculty observed MD students were open to IPE and OH but were not positive in practice as reflected in their aversion to the OH lecture conducted by the DPHPM faculty	The overall RIPLS scores for the MDs demonstrated the were the least ready to engage in IPE and OH which was supported by the insights provided by faculty. The rationale provided for this was the lack of accreditation requirements for OH and IPE in the MD programme. A significant reason of the MD students' resistance to engage in IPE and OH is that it is not an examinable component of their qualifying exams. Thus, they view time spend on this as a distractant from more important things

\*Roopnarine and Boeren.<sup>15</sup>

the additional emphasis on OH and the role of the effect of environmental factors on public health. Faculty explained that MD students were the least ready for interprofessional learning as reflected by their lack of participation in the campus OH clinics and their negative attitude towards the one lecture given to them introducing them to the concept of OH. Faculty also explained the reasons for why MD students perceived OH was only about human health and were unaware of the roles of

environmental and animal health to the concept. OH is not an accreditation requirement for the qualifying exams for the MD programme and thus students are not aware of the value of interprofessional collaboration with health professionals outside of the medical and allied health groups.

The dual degree students again had the highest scores for the RIPLS subscales 'Positive Professional Identity' and 'Teamwork' and perceived the importance of collaboration with

other health professional groups as representing the embodiment and relevance of the OH concept.<sup>14</sup> The greater emphasis placed on the importance of these subscales by the dual degree students, are explained through the qualitative data as being due to a lack of an accreditation mandate for IPE and OH in the singular MD and DVM curricula. The RIPLS items associated with Roles and Responsibilities revealed that MD students agreed with the statement that ‘the function of nurses and therapists is mainly to provide support for doctors’. Their support for this statement is consistent with their perception of OH as centred on human healthcare without any consideration of the need for interprofessional collaboration. The MD students also yielded the lowest score for Negative Professional Identity as is consistent with the group being the least ready to engage in IPE.

### Discussion

In this study, the MMR approach provided a comprehensive assessment of the readiness for IPE by students. Insights from the student survey responses as well as their own expertise enabled faculty to provide in-depth insight into the rationale for the differences in student readiness for IPE across the programmes.

### Theoretical Explanation for Integration

Through the process of integration, role theory was linked to the TSE. Faculty drew on the gaps in the student’s knowledge about OH and differences depicted by their RIPLS scores. The greater readiness of the dual degree students for IPE and OH was linked to role theory which suggests that the MPH programme exposes students to shared learning and OH in a way that promotes the benefits of interprofessional collaboration for public health practice. In contrast, the culture of medicine and the qualifying examinations for the discipline, are believed to contribute to MD students yielding the lowest readiness scores as students are not expected and required to engage in shared learning with veterinarians in their future professional roles. The MD students also reported the least accurate definitions in describing the concept and relevance of OH.

Using the TSE model, it was possible to identify the needs of the specific institution based on gaps in the student’s knowledge about OH, opportunities for developing IPE and OH based on its perceived value and importance for future practice. Also discussed were the challenges to developing the intervention that logically flows from the results of this study, in order to eliminate problems relating to low readiness for IPE.

The results of this study indicated that core OH competencies should ideally be incorporated within the MD curricula.<sup>16</sup> Roopnarine et al<sup>16</sup> compare and discuss the distribution of OH content across the curricula of each programme and suggest content that should be brought to the table of the MD and DVM programmes. The curriculum of both the MD and DVM programmes should include core of socio-cultural and environmental factors on the occurrence of zoonoses; the dangers of antimicrobial resistance for both animal and human

health; the impacts of global warming including emergence of vector borne diseases, natural disasters, heatstroke and respiratory diseases on their patients. IPE and OH Faculty across the disciplines that already teach courses relevant to OH champions, can be involved in developing Communities of Practice (CoPs)<sup>23</sup> that involve students in IPE and OH activities that can assist the maturation of the student’s interprofessional identity, appreciation of the benefits of shared learning and the relevance of executing the principles of OH for practice.

### Recommendations for Future Studies

This was the first known research study that used a MMR approach that allowed an integration of quantitative data on student readiness and a faculty evaluation of these data to inform the development of IPE that includes OH. This research approach could be further extended into practice where researchers could couple the data obtained from pandemics on death and case occurrence obtained through epidemic curves, with qualitative data obtained by researching the possible social, economic and behavioural reasons that impact the occurrence of diseases like SARS CoV-2. The latter is critical for influencing and driving policy development in favour of OH.

We would recommend that other medical and veterinary educators embark upon the use of MMR studies that would enable a comparison to be made to our own findings and whether these findings are similar to those at other contexts. Specifically, educators could obtain survey data before and after applying an IPE/OH intervention and obtain qualitative interviews data from students describing any changes in their readiness for IPE and perceived relevance of OH. These studies could be expanded to include students in their clinical years and earlier stages of the programme, to observe differences in readiness scores at different stages of their programme using the RIPLS and obtaining student focus group data across the programme to provide an explanation for their scores and responses about OH and its relevance. The use of faculty evaluators to assess these responses could contribute information about what factors promote interest in IPE /OH and its perceived benefits, as well as providing information on the best place to implement the intervention in the curricula.

### Limitations

This study was only conducted at a single institution. This deters a generalisation of these findings to other institutions elsewhere. Also, in surveying the students using Qualtrics, the study may have been limited in its quantitative approach, as it did not allow for students to provide their own rationale for their responses about OH or feelings about interprofessional learning in a follow-up interview.

### Conclusion

This study enabled us to compile an assessment of the needs, opportunities and challenges for informing the development of an IPE/OH intervention in an offshore medical school. Integration of the student data with the faculty assessment of the

institutional needs through the use of an MMR approach, provided a nuanced perspective that enabled us to provide recommendations for enhancing the curricula of the MD and DVM programmes. Specifically, accreditation mandates for MD and DVM programmes should incorporate OH so students perceive the concept as relevant to their roles as future practitioners.

Importantly, these findings have implications for tailoring such interventions to prepare graduates to understand their roles and those of other health professionals in eliminating, preventing and controlling the occurrence of emerging diseases such as COVID-19.

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### Author Contributions

Dr. Rohini Roopnari designed the study as part of her doctoral thesis. Professor Ellen Boeren, as the primary investigator's doctoral supervisor, assisted in the design and also the preparation and editing of the final manuscript.

### Ethical Approval

Ethical approval was granted.

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