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An Innovative Approach to Teaching Master of Public Health Candidates the Complexities of Environmental Health

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ABSTRACT

Environmental disasters and their prevention have generated a large demand for trained public health professionals in environmental health. Team based learning (TBL) and problem based learning (PBL) are essential to develop public health practitioners' critical thinking skills. A graduate level introductory environmental science course was designed to cover 15 environmental domains reinforced by six TBL and PBL assignments. We conclude that PBL and TBL are innovative approaches in helping students meet the core competencies for the environmental components of a master of public health. This course structure and approach could be successfully implemented in other classes.

KEYWORDS
Public Health education, Team based learning (TBL), Problem based learning (PBL)

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Introduction

Environmental disasters and their prevention have generated a large demand for trained public health professionals in environmental health. Given the current urgency and deep complexity of environmental disasters, it is imperative to inform students and provide them with skills that can immediately be employed (Mumford, Young, & Nawaz, 2016; Crawford et al., 2009; Tilson & Gebbie, 2004; Baker & Koplan, 2002; Koplan & Fleming, 2000; Ryan et al., 2016). Public health education is starting to transition to more applied approaches through team based learning (TBL)(Michaelsen, Davidson, & Major, 2014) and problem based learning (PBL)(Albanese & Mitchell, 1993) which serve to empower students by instilling competencies to become effective public health practitioners (Polyzois, Claffey, & Mattheos, 2010; Dolmans,

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Michaelsen, Van Merri Nboer, & Van Der Vleuten, 2015). This approach is not only being utilized in public health curriculum, but in environmental health, medicine, and health professions curricula.

The Council on Education for Public Health (CEPH), the accrediting body for the Central New York Master of Public Health (CNYMPH) Program, has identified five areas of knowledge basic to public health: Biostatistics, Epidemiology, Environmental Health, Health Services Administration, and Social and Behavioral Science. These concepts and related competencies from these five areas must be integrated into all of the curricula within the CNYMPH Program. These five core areas along with the program specific competencies are the baseline expectations of our graduates (Council on Education for Public Health).

The Association of Schools and Programs of Public Health (ASPPH) developed core public health competencies to standardize the field and guide the education. ASPPH Master of Public Health core competencies focused around the environmental health sciences include studying "environmental factors including biological, physical and chemical factors that affect the health of a community". In addition, eight more competencies further detail specifically what is covered under each of the environmental factors as standard Master level skills (American Public Health Association, 2016). However, there has been less attention given to the pedagogical approach that helps students synthesize the complex and interdisciplinary field of environmental health with application and critical thinking skills.

This paper contends that combining team based learning (TBL) with problem based learning (PBL) is critical in developing environmentally focused, public health practitioners' critical thinking skills. The paper reviews 6 assignments that incorporate TBL and PBL, along with their corresponding student evaluations.

Competencies and Pedagogical Approach

The Principles of Environmental Health course for the CNYMPH Program has competencies developed from merging and synthesizing the ASPPH (American Public Health Association, 2016) and the CEPH (Council on Education for Public Health) competencies. The competencies are listed below.

Table 1: Overarching Learning Objectives for Core Principles in Environmental Health

Learning Objectives	Program Specific Competency
L1. Students will be able to summarize the major domains of environmental health and their impact on public health. (P2, P3, P5, P15)	P.2. Recognize, evaluate and control public health hazards at the population level. P.3. Apply current knowledge of the distribution of disease and determinants of health to guide public health decision-making.
L2. Students will evaluate the biological, social, cultural, and political factors in both the onset, impact and solution of environmental events. (P2, P4, P6, P7, P8, P9, P10, P11, P12,	P.4. Compare, contrast, and recommend appropriate study design methodology for investigating a public health issue. P.5. Apply appropriate community assessment strategies to investigate, diagnose and solve public health issues. P.6. Identify and evaluate the interrelationships of systems that

P13, P14, P16, P18, P19)	influence the health of a community.
L3. Students will develop culturally sensitive health risk communication plans for an environmental health hazard (P6, P7, P8, P9, P10, P11, P13, P17, P18, P19)	P.7. Identify and assess social, cultural, economic and behavioral determinants of health outcomes and disparities. P.8. Synthesize and apply health related beliefs and practices to the development, implementation and evaluation of public health programs, services, and policies.
L4. Students will inventory the interpersonal, community, and organizational resources required to address environmental health. (P5, P6, P8, P9, P10, P11	Competency P.9. Assess public health resources, identify gaps and develop strategies to meet the needs of the community. P.10. Demonstrate how to appropriately address cultural competency issues for a population.
L5. Students will judge the best practices in creating, implementing and evaluating an intervention to address environmental health events. (P2, P4, P8, P9, P10, P11, P12, P13, P15, P16, P18, P19)	P.11. Collaborate with key stakeholders in the planning, and/or implementation and evaluation of public health programs, policies, and interventions. P.12. Describe the role of costs, financing, organization and access to care on the structure, process and outcomes of public health interventions. P.13. Apply principles of program planning including design, implementation, budgeting, and evaluation.
L6. Students will inventory the public health infrastructure to manage, track, and control organizational resources in our environment. (P3, P5, P8, P9, P10, P11, P12, P13, P17, P18, P19	P.14. Assess and recommend policies for improving the health status of populations using appropriate local, state and federal policy processes. P.15. Critically appraise the literature and apply appropriate analytical skills to public health practice. P.16. Adhere to the laws, regulations, and/or policies and procedures for ethical conduct of public health research and practice. P17. Demonstrate ability to communicate and disseminate information to an audience using a variety of information management technology and communication tools. P.18. Apply ethical principles across the continuum of public health practice and policy. P.19. Apply core public health principles and scientific knowledge base to research, critical evaluation, and/or decision-making in public health.

TBL is an educational approach that emerged in the late 1970s as a means to address difficulties faculty faced with increasing class sizes. Constructive student and student/faculty interactions in large classes presented challenges that were met with the four foundational practices of TBL: (1) strategically formed permanent teams (to enable students to "develop into effective self-managed teams"); (2) student preparedness with course content in advance of class meetings utilizing a "Readiness Assurance Process"; (3) in-class team assignments to apply course concepts; and (4) a peer assessment and feedback system (Michaelsen et al., 2014). Evidence documenting the strengths of the TBL system is abundant, and it has been applied in secondary education programs in business, sciences, health professions, and liberal arts. A summary of the research on TBL in practice can be found in a literature review by Haidet, Kubitz and McCormack (Haidet, Kubitz, & McCormack, 2014).

PBL is a learner centered approach developed at McMaster University in a medical education setting in the 1960s, and centers on the concepts that "problem solving [is] the main reason for learning…" and "the learner is required to solve a specific problem whilst acquiring knowledge on how to solve similar problems" (Jones, 2006). Both PBL and TBL methods are structured around small groups; however PBL groups are led by a facilitator rather than self-managed. The PBL facilitators may or may not be content experts regarding the problem posed, and also must possess specialized skills in addition to curricular content to successfully guide the small groups. PBL is not part of a didactic curriculum, it "must be the pedagogical base in the curriculum" (Savery, 2006). Many studies have been conducted on the successes and challenges of PBL in medical education, and the comparative effectiveness of PBL remains a topic of debate (Neville, 2009; Polyzois et al., 2010). The combination of PBL and TBL allows for the combination of two learning approaches and optimizes student learning (Dolmans et al., 2015).

Selecting the TAG Topics and descriptions

The course director held several brainstorming sessions with different institutional faculty to identify problems, topics, and elements of a TAG. The sessions identified four main considerations for TAGs: 1. contain a problem or issue related to environmental public health; 2. specific learning objectives that illustrate the complexity of environmental health; 3. reinforce or introduce a public health skill and 4. challenge the students to synthesis and problem solve concepts related to environmental public health.

Table 2: Learning Objectives, Summary, and Public Health Skill Sets of TAGs

TAG	Learning Objectives	Summary	Skills and Tools
TAG 1: Risk Assessment	L1., L3, L4., L5, L6	Understanding risk and risk reduction by using the conversation of electronic cigarettes	Skills: Health communication and risk assessment interpretation, data interpretation, critical thinking, teamwork Tool: Quantifiable risk through calculations
TAG 2: Infectious Disease	L1., L2., L3.,L4, L5, L6	Understanding why malaria and net intervention may not be effective in some environments	Skills: Interpreting the complex intersection of the society, public health intervention, and the environment (Public Health Intervention and the Environment) Tool: Venn-diagram
TAG 3: Toxicology	L1, L3, L4, L5, L6	Develop public health messages for different community audiences	Skills: Health communication and risk assessment interpretation, data interpretation, critical thinking, teamwork Tool: Toxtown tool- NIH; Health communication and risk

			assessment interpretation
TAG 4: Built Environment: Active Design – shaping the sidewalk experience	L1, L2, L3, L4, L5, L6	Apply concepts from walk ability from a built environment and architectural standpoint and connect the built environment to public health	Skills: data interpretation (built environment and architecture), mapping interpretation, critical thinking, teamwork Tool: Google Maps
TAG 5: Outdoor Air Pollution and Social Justice	L1, L2, L4, L5, L6	Interpreting environmental data and linking Social justice	Skills: data interpretation, Mapping interpretation, critical thinking, teamwork Tools: Environmental Justice Mapping
TAG 6: Global Health Experiment	L1, L2, L4, L6,	Global Health Experience - resource distribution and the impact on the environment and public health	Skills: data interpretation, Mapping interpretation, critical thinking, teamwork, resource allocations, decision making and public health negotiation Tools: WHO, World Bank

TAG Descriptions (see Table 2)

TAG 1: Risk Assessment

The first TAG explored the use of e-cigarettes, and the corresponding risks and potential benefits. The lecture explored the concepts of risk, steps in risk assessment, and communication strategies of risk. For the TAG, students were pre-assigned literature and a video about e-cigarettes. Students were asked to explore the quantifiable risks with the device, e-liquid constitutes, secondary exposure, and use patterns. In addition, student's explored regulations and policies related to e-cigarettes from a public health perspective, and grappled with the social constructs related to risk.

TAG 2: Infectious Disease

The second TAG demonstrated the complex nature of preventing the transmission of infectious disease. The TAG focused on the use of nets as a malaria prevention intervention. The lecture also reviewed the major environmental factors that have contributed to the increase of infectious diseases. For the TAG, students specifically focused on the malaria transmission cycle, intervention strategy – nets, and environmental factors that lower prevention strategy efficacy. Students were asked to read a newspaper article that described the malaria nets being used as fishing nets and watch a 5 minute documentary describing the scenario. Students were also asked to describe the impact of the intervention on society and the environment and identify which societal shift should be targeted to increase net use for malaria prevention through a Venn Diagram.

TAG 3: Toxicology

The third TAG focused on available toxicology informational resources and communication strategies based on different target audiences and environmental exposures. Because toxicology is an extremely broad field, the

TAG was used to help students learn how to navigate the wealth of information available and be able to identify pertinent resources. During the lecture, the students reviewed the adverse effects of chemical, physical, or biological agents on living organism and ecosystems. Specifically, for the TAG, students focused in Bisphenol A (BPA) and Lead. Students were directed to the National Institutes of Health and the National Library of Medicine website called "Tox Town". "Tox Town" is an interactive toxicology website that allows one to explore a variety of resources for the identified toxins. Students were asked to create brief public health messages based on a scenario using the information from "Tox Town" (National Institutes of Health, 2002). As discussion points, student were ask to compare and contrast communication strategies, content summarization, public health impact, and prevention strategies, and exposure routes.

TAG 4: Built Environment

The fourth TAG asked students to critically appraise the built environment. Students learned about the connection between the built environment and health. For the TAG, students specifically focused on 6 different addresses with direct sidewalk access within the local community. Students used Google Maps© to virtually explore the sidewalk and grade the sidewalk on key aspects: integrity, safety, accessibility, lighting, and connectivity (Google). Students took time to discuss the canopy, roadside, ground plane, and building side of the sidewalk. As discussion points, students were asked to describe how the sidewalk environment could impact public health and identify changes that might mitigate barriers of use.

TAG 5: Outdoor Air Pollution and Social Justice

The fifth TAG asked students to explore the concepts of outdoor air pollution and social justice. The lecture covered historical milestones, sources of outdoor pollution, the impact on public health and environmental health, and concepts of environmental justice. The TAG built on the lecture by requiring students to become familiar with outdoor air pollution indexes through the EJSCREEN: Environmental Justice Screening and Mapping tool (U.S. Enviromental Protection Agency). Students were asked to appraise the levels of outdoor air pollution around different socioeconomic areas in the Syracuse, NY area. As discussion points, students explored the reasons some communities were disproportionally affected by air pollution. Students discussed advocacy, prevention, and intervention strategies.

TAG 6: Global Health Experiment

The sixth TAG brought to life the complexity of global health and the environment. The lecture covered the general concepts of global health, critically assessed the impact of the global environment on health, summarized the connection between global health and public health, and explained the negative health effects of global environmental change. The TAG built on the lecture by allowing students to experience public health negotiation and resource allocation. Students were assigned countries and explored the health and economic states of each country through the World Health Organization (World Health Organization) and the World Bank (The World Bank) websites. Students were provided pre-assigned environmental resources that could be

traded for humanitarian survival. Students within each country experienced the unequal distribution of resources worldwide (6 different countries) and attempted to balance assistance to other countries, while trying to retain resources for their country's survival. As discussion points, students explored the overall power struggle that existed between the disadvantaged countries and the developed countries. This exercise helped students understand the inequitable distribution of environmental resources worldwide.

Course Structure and Logistics

The course was designed as a 15 week graduate level introductory environmental science course that covered 15 different environmental domains: global health, healthy housing, indoor air pollution, outdoor air pollution, social justice, food production and security, built environment, water quality, toxicology, occupational health and safety, liquid waste, solid waste, energy resources, risk management, current and historic environmental disasters.

The class met face-to-face every other week of the 15 week course. Each bi-weekly class (other than the first meeting and exam weeks) began with an introductory 1.5 hour lecture to cover the background of the domain and the content necessary to understand high level concepts within the field. The lecture built upon the mandatory pre-reading. The lectures were followed by a facilitated TAG; small groups contained 4-5 students. To foster diversity (e.g. social scientists, doctors of medicine, traditional and non-traditional students) within the groups, all students in the course were randomly pre-selected to the TAG groups using an electronic course management system. Students were able to access their pre-selected group rosters using Blackboard.

Each TAG group was presented with detailed instructions that reviewed the goals of the TAG session, highlights from the lecture, directions on applying concepts and/or resources from the lecture, and group submission instructions. All TAGs had mandatory reading (before class) that help "set the stage" for the TAG. All TAG assignments were developed to ensure they could be completed by students and submitted to Blackboard within the 1.5 hour in-class small group meeting timeframe. After each TAG session, students completed an evaluation on the lecturer and the TAG assignment.

Course Monitoring and Evaluation

Monitoring

The course director monitored the class TAG groups. During the session, the instructor 'floated' to each TAG group to ensure that the learning objectives were being met and that all students participated in the completion of the group assignment. At the end of the TAG, the director facilitated further class discussion to reinforce the concepts learned through the lecture and TAG. Usually, students exceeded the TAG learning objectives and developed several new objectives and/or developed a higher level of critical thinking. On many occasions, students stayed after class or made appointments with the course director outside of the classroom to apply a higher level of critical thinking beyond the learning objectives.

Evaluation

Anonymous online evaluations were developed and deployed specific for the lecturer and the TAG. Online evaluations were available during the last 15 minutes of class and were available until the following week or until all students completed the evaluation.

Twenty-six students were enrolled in the course. The majority of students were female (N=19) and were considered full-time students (N=20).

Lectures:

There were 6 lecturer evaluations completed over the 15 week course (see table 3). The 6 lecturer evaluations were combined and 142 evaluations were analyzed. A Likert scale (Strongly Agree, Agree, Undecided, Disagree, and Strongly Disagree) was used to rate the speaker.

The evaluations revealed students overwhelmingly felt that the speakers clearly presented the content (59.2% (N=84) "strongly Agree"). Students felt that the speakers content matched the subject area (64.1% (N=91) "Strongly Agree"). Overall, the students reported that the speaker was effective in delivering the content (60.6% (N=86) "Strongly Agree").

Table 3: Speaker Evaluations

Please rate your agreement with the following statements:	Strongly Agree % (N)	Agree % (N)	Undecided % (N)	Disagree % (N)	Strongly Disagree % (N)	Evaluation total
The speaker clearly presented the content	59.2 (84)	33.1 (47)	4.9(7)	2.1(3)	.7(1)	
The speaker presented content that match the subject area	64.1(91)	30.3(43)	4.2(6)	.7(1)	.7(1)	N=142
Overall, the speaker was effective	60.6(86)	34.5(49)	2.8(4)	0	2.1(3)	

TAGs:

There were 6 TAG evaluations completed over the 15 week course (see Table 4). The 6 TAG evaluations were combined and 140 evaluations were analyzed. A Likert scale (Strongly Agree, Agree, Undecided, Disagree, and Strongly Disagree) was used to rate seven evaluation questions about the TAG.

Student evaluations showed that the majority of the students felt that the TAGs required them to work in teams (62.9% (N=88) "Strongly Agree"), to problem-solve with their team (62.9% (N=88) "Strongly Agree"), required them to apply general public health knowledge to the scenario (58.6% (N=82) "Strongly Agree"), expanded their understanding of the lecture (52.1% (N=73) "Strongly Agree"), required them to apply concepts from the lecture (47.1%

(N=66) "Strongly Agree"), challenged their intellectual understanding of public health (493% (N=69) "Strongly Agree"), and overall, were an effective learning experience (58.6% (N=82) "Strongly Agree").

Table 4: TAG Evaluations

Please rate your agreement with the following statements:	Strongly Agree % (N)	Agree% (N)	Undecided % (N)	Disagree % (N)	Strongly Disagree % (N)	Evaluation total
required you to work in a team	62.9(88)	34.3(48)	.7(1)	1.4(2)	.7(1)	
required you to problem solve with your team	62.9(88)	33.6(47)	1.4(2)	1.4(2)	.7(1)	
required you to apply general public health knowledge to the scenario	58.6(82)	33.6(47)	4.3(6)	2.1(3)	1.42)	
expanded your understanding of the lecture	52.1(73)	35(49)	8.6(12)	2.9(4)	1.4(2)	N=140
challenged your intellectual understanding of public health	49.3(69)	36.4(51)	8.6(12)	4.3(6)	1.4(2)	
required you to apply concepts from the lecture	47.1(66)	37.9(53)	10.0(14)	2.9(4)	2.1(3)	
Overall was an effective learning experience	58.6(82)	32.9(46)	4.3(6)	1.4(2)	2.9(4)	

University based Mid-Course Evaluation

The mid-course evaluations were deployed using an on-line survey tool. Students were provided a link to the survey and were asked to complete the evaluation. The mid-course evaluation data was synthesized by the course director. These data were presented to the students and additional oral feedback was requested to clarify comments on the mid-course evaluation. Course improvements were developed based on the feedback and were

communicated to the students. The major mid-course improvement was the development of PowerPoint slides at the beginning of each face-to-face class that reviewed the class goal, objectives, and the connection to the TAG.

Students overwhelmingly reported that the course improved their understanding of the subject "Strongly Agreed" (43%), "Agreed" (57%).

University Overall Final Course Evaluation:

The University overall final course evaluation was deployed by the medical school course evaluation system. Students were solicited through email and were asked to complete the evaluation online. The University overall final course evaluation was completed by nineteen students and was synthesized by the course director and the MPH director. These data were reviewed and will influence future iterations of the course. The majority of the final course evaluations showed favorable feedback. On a scale of 1-5, where 1 is strongly disagree and 5 strongly agree, students reported on average: the course was well organized and run well (average of 4.63 StD 0.5), provided a positive learning environment (average of 4.84 StD 0.4), and improved my knowledge of the subject (average 4.53 StD 0.6).

Grading:

Electronic submission of assignments through Blackboard constituted successful attainment of course competencies. The grading rubric for each technical assistant group assignment was designed to assess whether groups had satisfactorily obtained the goals. Because the TAGs represented a synthesis of the group discussion and did not present one individual group, a group grade was provided. Environmental health domain knowledge acquisition by students in the course was also assessed with exams and individual assignments for overall synthesis of knowledge.

Lessons Learned

Student Perspective

The students generally appreciated having the class broken up into two components due to the length of the classes (3 hours). Students felt that the lectures set the foundation for the TAGs. Students liked the intimate setting the TAGs provided, the opportunity to apply some of the concepts from the lecture, and the diversity of the classroom experiences. They felt the co-learning with their peers further developed their understanding of the content.

Students appreciated being able to complete their group assignments in class because of the difficulty of peer coordination outside the classroom, but also because they were able to have the course director answer questions, provide anecdotal information, and/or facilitate a deeper discussion among the group participants.

There were several evaluation tools used throughout the course, however, students did not report feeling burdened by the tools. Instead, students seemed very engaged in learning how their peers felt about the TAG assignments.

Initially, several students expressed confusion over the connection between the lecture and the TAG. This was alleviated through reviewing the

goals, objectives, and the connection of the TAG at the beginning of each class. Some students were frustrated because the TAG assignment did not have a clear correct answer and required groups to explore several solutions. Many students preferred to have long class discussions after each TAG which required the director to shorten the TAG assignments half way through the course; some of the group discussions were eliminated.

Instructor Perspective

The instructor workload was heavy prior to the course and was satisfactory throughout the course. Group assignments diminished the grading substantially.

On one occasion, it became clear that there was a learning deficiency in assumed subject matter from the previous semester. This was overcome in the moment by teaching the concept. This void was presented to the faculty council and will be addressed earlier in the Program's curriculum.

Conclusion

In conclusion, PBL and TBL are innovative approaches in helping students meet the core competencies for the environmental components of a Master of Public Health. Students favorably supported the PBL and TBL format within this context. This course structure and approach can be successfully implemented in other classes.

Disclosure statement

The Authors reported that no competing financial interest.

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