THE CONSTRUCTING OF FIELD EPIDEMIOLOGISTS IN THE PERIPHERY OF COMMUNITIES OF PRACTICE: A QUALITATIVE INVESTIGATION INTO LEARNING IN FIELD EPIDEMIOLOGY TRAINING PROGRAMS

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Declaration

I, Matthew Myers Griffith, confirm that this thesis is my original work. As a thesis by compilation, this work contains manuscripts submitted for publication that I developed in collaboration with others:

- "COVID-19 and investment in applied epidemiology," (Chapter 2)
  - 809 words
  - *Bulletin of the World Health Organization*
  - Published (2022 July)
  - Collaborating authors: Amy Parry, Tambri Housen, Martyn Kirk, Tony Stewart
  - My contribution: Developed main ideas of the manuscript in collaboration with coauthors, drafted the manuscript, responded to editor comments, revised the manuscript.
- "Case study: Adult learning and public health—a foundational training programme in field epidemiology with lessons and opportunities for collaboration" (Chapter 3)
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  - Collaborating author: Barbara Pamphilon
  - My contribution: Developed the research questions, searched the literature, compiled and analysed the case, drafted the manuscript, responded to reviewer comments, and revised the manuscript.
- "How do field epidemiologists learn? A protocol for a qualitative inquiry into learning in field epidemiology training programmes" (Chapter 4)
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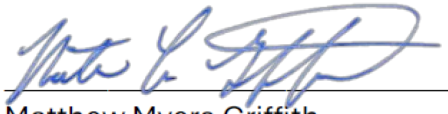

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—M.M. Griffith (March 2025, Vientiane)

Abstract

Field epidemiology addresses urgent health problems to quickly inform prevention and control interventions. Field epidemiologists use epidemiological tools to conduct surveillance and investigate outbreaks of disease to provide decision-makers with information to control and prevent diseases. For 75 years, field epidemiology training programs (FETPs) have been the primary training mechanism, with one hundred programs operating globally today. Typically, FETPs feature a month-long course and one to two years of service-based, hands-on learning to build competence in public health surveillance and outbreak detection and investigation. Though studies often evaluate FETP outputs and outcomes, research into learning processes is limited. This thesis addresses that gap, exploring how learning occurs within FETPs through three questions: 1) What were the learning approaches in the foundational FETP? 2) What are the learning approaches in contemporary FETPs? 3) Where do principles and practices misalign in FETPs?

To address the first question, a case study of the foundational FETP—the US Epidemic Intelligence Service (1951–1970)—used inductive content analysis of published documents. It showed alignment with Malcolm Knowles's andragogical principles, David Kolb's experiential learning cycle, and Jean Lave's and Etienne Wenger's *legitimate peripheral participation in communities of practice*, revealing a constructivist, humanist, and situated learning approach. To explore the second question, I co-designed a qualitative study with four contemporary FETPs: Australia, Japan, Mongolia, Taiwan. Data collection included participant observation and 47 in-depth interviews with six advisors and 19 trainees. Analysis followed Charmaz's grounded theory and Polkinghorne's narrative inquiry, synthesizing narratives into program-specific case stories and reviewing these for verisimilitude with each program's coresearcher. Cross-program comparisons revealed a common learning process in which trainees engaged the data, knowledge, people, and systems of public health contexts to revise or reinforce knowledge. Enabling factors included learning environments, trainee tenacity, and advisor stewardship. Routine work placements were the most robust learning environment, while courses contributed the least. Further analysis of advisor stewardship yielded three components: assigning trainee

roles and responsibilities, “laying the groundwork” for trainee activities, and adaptive engagement. Modes of engagement comprised a six-scale spectrum ranging from hands-off to hands-on. Advisors aimed for gradual shifts toward hands-off modes, but they adapted to the culture, trainee characteristics and learning needs, task urgency and complexity, and advisor-to trainee ratios. These findings revealed misalignments (question 3) between the global focus on curriculum design and the reality of learning through practice, as well as between advisors’ desired and actual modes of engagement.

This thesis provides contemporary evidence of FETP learning processes across diverse contexts, offering insights to inform evaluation and improve practice. It expands Lave and Wenger’s legitimate peripheral participation in communities of practise by illustrating how FETP advisors balance legitimacy and peripherality to construct trainee competence while minimising public health risks. By illuminating the learning process in FETPs, this thesis addresses a critical gap in the literature, points to implementation pathways for building field epidemiology capacity, and advances the application of communities of practice theory in contemporary, globally relevant contexts. Its findings emphasize the importance of learning in context, learning environments, advisor stewardship, and trainee tenacity. It introduces a spectrum of adaptive modes of advisor engagement with trainees. Lastly, it presents concrete recommendations to enhance trainee learning based on the findings and identifies further directions for research to inform FETP practice and policy.

List of Abbreviations

AAAHRH	Asia Pacific Action Alliance on Human Resources for Health
AC	Abstract Conceptualization (Kolb's Learning Cycle)
AE	Active Experimentation (Kolb's Learning Cycle)
ANU	Australian National University
ANZAHPE	Australia and New Zealand Association for Health Professional Educators
BMC	BioMed Central (journals)
BMJ	British Medical Journal
BS	Bachelor of Science
CDC (Taiwan)	Taiwan Centers for Disease Control
CE	Concrete Experience (Kolb's Learning Cycle)
COHFE	Competencies for One Health field epidemiology
COP	Community of Practice
COVID-19	Coronavirus disease 2019
CRG	Critical Reference Group
EIS	Epidemic Intelligence Service (USA)
FETP	Field Epidemiology Training Program
MAE	Master of Applied Epidemiology
MD	Doctor of Medicine
MPH	Master of Public Health
MS	Master of Science
NA	Not Applicable
PDR	(Lao) People's Democratic Republic
PI	Principal Investigator
RA	Resident Advisor
RO	Reflective Observation (Kolb's Learning Cycle)
SAFETYNET	The South Asia Field Epidemiology and Technology Network
SARS-CoV-2	Severe Acute Respiratory Syndrome coronavirus 2
TEPHINET	Training Programs in Epidemiology and Public Health Interventions Network
US CDC	United States Centers for Disease Control and Prevention
USA	United States of America
WHO	World Health Organization

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Chapter 1 Introduction

. . .yeah, they were just kind of really interesting people doing interesting work, and [FETP] was the common denominator. And I wasn't the only one that noticed this, that, you know, what's this cult that's propelling people to the top?

— second-year FETP trainee, Australia

I began this thesis concerned about standardized approaches to training. I was fascinated with the influences of culture, gender, and context in shaping learning and epistemology; aware of the risk of imposed global models and curricula without adaptation and respect for local contexts; and worried that such imposition would reify global power inequities. The strange ways of the universe had brought me to field epidemiology training programs—a subject ripe for research—years earlier, but I will say more about me later.

A need for research

Field epidemiology is an essential public health function. Goodman, Buehler, and Mott define it as 'investigations initiated in response to urgent public health problems' with the primary goal 'to guide, as quickly as possible, the processes of selecting and implementing interventions to lessen or prevent illness or death when such problems arise' (2019, p. 3). More simply, field epidemiologists investigate outbreaks of disease to give decision-makers better information to stop outbreaks and prevent future ones. A survey conducted during the COVID-19 pandemic illustrates field epidemiology's importance and the breadth of activities, showing that governments activated field epidemiologists to detect cases, assess the risk and spread of SARS-CoV-2, and

disseminate information by working in surveillance, case investigation, response coordination, border monitoring and control, and risk communication and community engagement (Hu et al., 2022).

Three aspects of field epidemiology make its learning context beckon exploration. First, field epidemiologists must adopt a broad range of knowledge. They need to understand concepts and methods from clinical medicine, epidemiology, laboratory and behavioural sciences, and decision theory, as well as communication and common sense (Goodman et al., 2019). They must apply these to unexpected problems in field situations and under demand or for rapid response. Field situations involve immediately available, incomplete, irregularly collected, and rapidly changing data; inadequate specimens; competing political and economic interests; public scrutiny; and reluctant community residents (Goodman et al., 2019). This unique need for field epidemiologists to have the aptitude for scientific methods, the talent for navigating field situations, and the initiative and creativity to apply methods in diverse situations urges research into how they learn to do this.

Second, for seven decades one training program has dominated the landscape—the field epidemiology training program (FETP). These programs are globally recognized as essential for public health: The WHO Joint External Evaluation, which is a monitoring and evaluation tool for the International Health Regulations (2005), identifies FETP as one of three key indicators for workforce development: countries with "developed capacity" (i.e., scoring 3 of 5[1]) should have an FETP or comparable program in country or an agreement with another country that has one (WHO, 2016, p. 49).

Throughout this thesis, I unpack the FETP training model. In Chapter 3, I describe the foundational FETP [see, The Case: EIS (1951–1970)]. In Chapter 5, I present the "Key elements of the four FETPs (2022–2024) included in [the] study" (Table 1). In Chapters 5 and 6, the main findings of the research describe and explain the common learning processes and learning facilitators across those four FETPs (see Results). So, the

[1] In JEE, countries receive scores of 1 (No capacity: Attributes of a capacity are not in place) to 5 (Sustainable capacity: All attributes are functional and sustainable, and the country is supporting one or more other countries in their implementation. This is the highest level of the achievement of implementation of IHR core capacities). For more information see https://www.who.int/publications/i/item/9789240051980.

training model, I hope, will become evident. Prior to conducting those studies, however, my knowledge of the training model came from working with the USA's FETP (the Epidemic Intelligence Service or EIS), working in Japan's FETP, and interacting with program leaders, trainers, and trainees in multiple FETPs. I could use that information to describe FETP for the reader, but to be rigorous, it behoves me to provide a pre-study description from published literature. As the reader will see, these descriptions leave much to be desired. Indeed, an early idea for the thesis was a systematic literature review to synthesize and map FETP training approaches. Through that process, I found that authors rarely described training approaches beyond 'learning by doing'.

According to the pre-study literature, FETPs are practical, competency-based, on-the-job training programs that prepare university graduates—typically from medical, nursing, or other health-related fields—to detect, investigate, and control disease outbreaks; conduct surveillance and studies of applied epidemiology; analyse data; and measure intervention impact (O'Carroll et al., 2021). Traditionally, these were two-year programs with 25% of training in classroom-based coursework on epidemiology, biostatistics, disease surveillance, outbreak investigation, leadership, and public health communication (see Figure 1.1). The remaining period comprised training in the field under experienced mentors. The 'field' meant a worksite placement, often in the ministry of health, a public health research institute, or a sub-national (e.g., provincial, district) health department. This training approach drew on the U.S. Epidemic Intelligence Service (EIS), which began in 1951 (Foege, 1996; Langmuir, 1980). In 1980, U.S. CDC began sharing the EIS model with countries and providing resident advisors and financial support to initiate FETPs (Jones et al., 2017; Music & Schultz, 1990). In 2003, U.S. CDC developed a standard curriculum of 16 competencies and 47 instructional goals that programs could choose to employ (Traicoff et al., 2008), which is available at https://stacks.cdc.gov.

Today, at least 98 FETPs are building capacity in more than 200 countries and territories (TEPHINET, 2023), and over time variation has occurred. In 2006, CDC developed a curriculum for a tiered structure based on the Central America FETP (Traicoff et al., 2015), which has become normalized as Frontline (about three months), Intermediate (9–12 months), and Advanced (up to two years), with each higher tier targeting more advanced skills and responsibilities. A multi-site evaluation in 2012

documented variation in implementation, with only one of the ten sites being national in scope, including full-time trainees, not granting a degree, and located in the national public health agency (Jones et al., 2014). Zambia's FETP-Advanced is an example of a degree-granting program. It links with a national university, includes seven months of coursework and then 17 months of field placement and grants a Master of Science in Epidemiology (Kumar et al., 2020). Papua New Guinea's FETPNG is an example of an intermittent delivery approach, where over eight months participants join three classroom workshops and return to their usual workplace between the workshops, spending 10% of their time on field-based epidemiology and intervention projects developed in consultation with mentors (Ropa et al., 2019). Programs have adapted competencies to their context, such as FETPNG's focus on intervention evaluation, though the core of outbreak investigation, surveillance, epidemiologic methods, statistics, and communication and approximately 25% classroom and 75% field training seem to be common. Assessment of competence also varies, with some using written tests for classroom work (Nguku et al., 2014), others requiring thesis-type submissions (Davis et al., 2016), and others using checklists for projects and tasks (H. Kamiya, personal communication, 21 December 2019). A non-profit organization representing the global network of FETPs offers accreditation, but its criteria do not include curriculum, competencies, nor training approaches (Tephinet, 2025). Thus, the endurance, spread, and global recognition of FETP imply there may be successful training elements across diverse contexts that should be understood through research to share within and beyond the FETP community.

Figure 1.1. Description of Field Epidemiology Training Programs.

What is a Field Epidemiology Training Program?

Traditionally modelled on US CDC's Epidemic Intelligence Service (1951 – present), FETP is a two-year service-based training program in applied epidemiology, positioned in a host country's ministry of health. FETP develops field epidemiologists for national and regional levels, mostly recruiting physicians, but also recruiting veterinarians, nurses, environmental health officers, and others. Training is competency-based, including classroom instruction and field experiences responding to public health emergencies like disease outbreaks and natural disasters, with at least 75% of the time practicing epidemiology in public health units under the supervision of proficient field epidemiologists. (Jones, 2014 P. 4)

Contemporary FETP includes three tiers: Advanced (2-years, as described above), Intermediate (7-15 months, like the first year of Advanced), and Frontline (3 months, targeted to surveillance officers). Though most FETPs remain in ministries of health, many programs have joint hosting with universities or are hosted completely by universities, some providing master's degrees. While most programs begin with a one-month, didactic introductory course, many have changed to interval-based training with multiple one- or two-week sessions interspersed with longer periods of supervised workplace assignments.

Third, misalignment between training theory and practice has emerged as a concern in FETP. Bensyl, King, and Greiner (2019) assert that the didactic model is the most used approach for training field epidemiologists in the classroom but that diverse learning modalities with hands-on, real-world experience are better. A mixed-methods study of field epidemiology supervisor roles identified the theme that supervisors should not teach didactically but facilitate learning and guide learners to ask appropriate questions (Forbes et al., 2019). Furthermore, based on leading around thirty training sessions for field epidemiologists in the Americas, Asia, and the Pacific, I have observed that training participants overwhelmingly prefer active to didactic

methods across cultures. Research on active learning methods in other fields supports these observations (Deslauriers et al., 2019; Freeman et al., 2014). FETP courses, however, remain didactic, as Bensyl et al. (2019) noted. Curiously, many FETP trainers, supervisors, and mentors who prefer learning active methods deliver didactic ones when leading sessions. Such cognitive dissonance as well as the focus on curriculum when 75% of the training is in the field begs exploration.

In summary, field epidemiology is an essential public health function and intriguing learning context that warrants research. It detects, controls, and prevents disease outbreaks; practitioners need a diverse range of scientific and interpersonal skills; the training mechanism, FETP, has spread across the globe for 75 years and is critical for public health workforce development; and despite the evidence and preference for active learning, didactic training persists in the classrooms, with less attention paid to field-based training. Governments and non-governmental organizations investing in FETP must ensure they are investing in appropriate evidence-based training approaches, and research can help them do so.

Problem Statement

Despite the clear value of research into FETP learning, systematic explanations of FETP learning processes do not appear in the published literature. Indeed, I abandoned two scoping reviews of field epidemiology training and learning with this thesis due to lack of suitable publications. FETP literature is mostly evaluations of program outcomes (see the scoping review by Al Nsour et al., 2024) or commentary (e.g., Bensyl et al., 2019; Griffith et al., 2018; Patel & Phillips, 2009). One study conducted in 2016 used surveys and focus groups with experienced FETP staff in the Asia-Pacific region to determine the characteristics of FETP supervision (Forbes et al., 2019). The findings describe general good practices for supervision, and the authors conclude that to 'better understand what and how effective supervision occurs, it would be worthwhile conducting further research in this area, particularly incorporating trainee viewpoints' (p. 17). This thesis aims to address this gap in knowledge of FETP learning processes.

Specifically, I hope that better understanding of FETP learning will lead to more effective and efficient training programmes. The findings of research into FETP learning could inform approaches to upscaling during emergencies and adapting global and

regional approaches to local contexts; clarifying the right balance between standardisation and localization; measuring and evaluating learning; and guiding training approaches to evolve with contemporary evidence and theory in adult learning. Furthermore, I expect research in this area to encourage future research into FETP learning across diverse geographical, economic, and program contexts.

Thesis Overview

Aim and Objectives

With this thesis, I aim to contribute meaningful knowledge of FETP learning processes to the FETP and public health workforce development community. An explanation of learning processes could inform program recruitment, training, and evaluation; guide trainers to be more effective learning facilitators; help trainees to identify and develop learning strategies; and inform adaptations of standard FETP competencies and training models to diverse contexts. Such knowledge should result in more efficient use of public health resources. Furthermore, explaining learning processes in this distinctive context could inform training and learning approaches in the broader public health workforce development field, also known as health professional education. Thus, through this thesis, I ask:

1. What were the approaches to learning employed in the foundational FETP, the 1951 to 1970 U.S. Epidemic Intelligence Service?
    - What can the learning approaches suggest about FETP's longevity and dissemination?
    - Where does the programme's learning approach locate FETP epistemologically?
    - How can the foundational FETP's learning approaches inform contemporary professional learning programmes for population health?
2. What are the learning processes in contemporary FETPs?
    - What are the approaches to training field epidemiologists in FETP?
    - What are the strategies for learning field epidemiology among trainees in FETP?

— What principles and practices align training approaches with strategies for learning in FETP?

Given some of the early review comments for published manuscripts in this thesis, I must pause here to clarify what this thesis is *not*: it is not an evaluation of FETP. It does not assess program outcomes or impact, does not compare training approaches nor learning strategies to determine which are more effective. Explorations of learning processes are rare in field epidemiology, and that is what this thesis aims to do: explore and describe the learning processes in FETPs.

Reflexivity statement

Upon commencing this thesis, I recorded a stream-of-consciousness reflection sparked by questions of value, motivation, positionality, and worldview. Here, I reproduce a summary that emphasizes a transformative, justice-oriented approach to learning and teaching in the context of public health and field epidemiology:

> *Learning is empowerment, a process that builds confidence and self-worth, enabling individuals to resist oppression and avoid perpetuating hierarchical power structures. I advocate for teaching methods that empower learners, focusing on confidence-building through challenges and reflection.*
>
> *I reject behaviorist learning approaches (e.g., B.F. Skinner) and favour experiential learning and participatory frameworks that emphasize reflection, application, adaptation, and more than anything the equal role of the learner in the learning process. I believe in the relativity of truths, the influence of metaphors of reality, and the need to view learning through diverse theoretical lenses and cultural contexts. I acknowledge constructed realities but recognize the value of practical outcomes, empowerment, and equity.*
>
> *Throughout my educational journey, I have recognized the importance of motivation, context, and self-study in learning, in parallel with the role of inspirational teaching methods. I have had transformative experiences with participatory and empowerment-oriented teaching approaches, which contrasted my dissatisfaction with didactic methods. Importantly, I am strongly influenced by Freirean educational philosophy (see Freire, 2000/1968). I believe in Freire's principles of education as liberation, fostering participatory and justice-oriented approaches in teaching and research.*
>
> *I believe in multiple realities and narratives, shaped by experiences with diverse perspectives, and reject absolute Truth and deterministic*

frameworks. I believe, like Kuhn (1962), that the incommensurability of these realities means that they cannot be judged against one another. I acknowledge the influences of Lao Tzu (Laozi & Walker, 1995) and Alan Watts (Watts, 2009/1966; Watts & Huang, 1975) on my worldview, while focusing my research on practical constructs and societal improvement.

With respect to my orientation to research, I come to this thesis as an epidemiologist who has developed a niche in public health as a learning facilitator, emphasizing the importance of collaboration, empowerment, and co-creation of knowledge. I hope to engage influential stakeholders (e.g., FETP directors and trainers) to create systemic changes in the FETP approach, rather than focusing on individual students. I seek a transformative agenda that can balance power and challenge unjust structures in educational and societal contexts.

Theoretical framework

I situate this thesis in constructivism and social constructionism. Patton (2015), citing Crotty (1998), links and distinguishes them by holding constructivism for epistemological considerations focused on how the mind makes meaning and constructionism focused on collective generation and transmission of meaning. Patton summarizes the distinction as constructivism pointing to the unique experience in each human, suggesting that each person's sense-making approach is valid, and social constructionism highlighting the way culture shapes how we see and feel the world.

As noted in the reflexivity statement, this thesis also leans into critical theory, especially the work of Freire (2000/1968). Critical theory rejects the positivist notions of truth, rationality, and objectivity; resists the idea that educational problems are technical issues; tries to differentiate ideologically distorted interpretations from those that are not; aims to expose social structures that distort rational goals; and sees theory as informing practice (Carr & Kemmis, 1986). According to Gouthro (2022), when applied to adult education, critical theory considers social structural factors, the pervasiveness of power in learning contexts, social purpose, and equity issues, as well as the needs of individual learners.

Importantly, my constructivist worldview implies that my positionality and biases cannot be held at bay. Furthermore, I believe that the most influential biases are the ones of which I am unaware. That belief is one of the reasons that I aimed for a

participatory approach to the research. Involving those who are actively engaged in the day-to-day practice of training field epidemiologists, especially when they are from different genders, educational and professional backgrounds, native languages, and ages strengthens the credibility of the research and interpretations and reduces the influence that my biases—known and unknown—might have on them.

Chapter summaries

Each of Chapters 2 – 6 presents a manuscript that has been published or submitted for publication. Below, I summarize each chapter. In brief, I begin with an editorial calling for smart investments in field epidemiology to improve training strategies, and following that I reframe the origins of FETP with an education-and-learning lens. Next, I present the protocol for a qualitative study investigating training and learning in contemporary FETPs and then present the FETP learning process and its key facilitators identified through the qualitative study. Afterwards, I take up one of those learning process facilitators—advisor stewardship—and clarify its dimensions and importance and then conclude with a discussion of the implications of this research for FETPs, the learning field, qualitative research, and critical participatory research.

Chapter Two: COVID-19 and the need for research into field epidemiology learning

This chapter presents an editorial published in *Bulletin of the World Health Organization* in July 2022, calling for better understanding of training in applied epidemiology. Applied epidemiology is the sub-discipline of epidemiology that includes field epidemiology (Koo & Thacker, 2010). With my co-authors, who have backgrounds in FETP and COVID-19 response, I draw on literature and experience to identify key challenges to applied epidemiology in the wake of COVID-19: insufficient numbers, inadequate training, and low government regard. I then recommend governments to institutionalize training programs, establish programs where absent, and tailor training approaches to specific needs, and I advocate for engaging learning professionals to improve training strategies.

Chapter Three: The foundational FETP with an unexpected learning approach

Chapter 3 presents a case study published in the peer-reviewed *International Journal of Lifelong Education* in January 2024. It examines the U.S. Epidemic Intelligence Service (EIS), the original FETP, through the lens of adult learning theories. The study identifies alignment with Knowles's (1989) andragogical principles, Kolb's (2015) experiential learning cycle, and Lave and Wenger's (1991) legitimate peripheral participation. It concludes that alignment with constructivist, humanist-situated learning could explain the EIS/FETP training approach longevity and suitability for population health.

Chapter Four: A methodology for investigating learning in FETP

This chapter presents the protocol for the primary study of this thesis published in the peer-reviewed *BMJ Open* in February 2024. It describes the qualitative, exploratory study codesigned with FETP trainers, using participant observation, in-depth unstructured interviews, and Charmaz's (2014) and Polkinghorne's (1995) analysis techniques. The study relies on constructivist grounded theory to generate explanations of training and learning and combines qualitative methods with a participatory approach to seek academically valuable and practical insights for FETPs and public health workforce development.

Chapter Five: The FETP learning process and its key facilitators

Chapter 5 contains the first of two manuscripts presenting the findings of the main study. In March 2025, *BMC Medical Education* published this manuscript. In it, I portray how trainees learn by engaging with public health contexts, interacting with people, systems, data, and knowledge, and how learning environments, trainee tenacity, and advisor stewardship facilitated the learning process. I then argue that these learning processes align with Lave and Wenger's (1991) situated learning theory, emphasizing the role of interaction with the practice for triggering self-driven learning and knowledge reinforcement. I recommend enhancing learning environments,

ensuring advisor accessibility, fostering trainee perseverance, and conducting further research into cultural contexts, advisor stewardship, and trainee tenacity.

Chapter Six: The critical roles of advisors in stewarding the periphery of the field epidemiology community of practice

In Chapter 6, I present the second manuscript of the main study's findings, which I submitted to *BMC Medical Education* in December 2024. In it, I describe how advisors shape trainee learning with their dual roles of 1) adapting engagement modes to build trainee competence and 2) opening the field epidemiology community of practice by bestowing trainee legitimacy and managing peripherality. Drawing on Lave and Wenger's work (Lave & Wenger, 1991; Wenger, 1998), I highlight advisor stewardship as a critical, actionable area for strengthening FETPs through targeted assessment and investment, particularly to ensure adequate advisor-to-trainee ratios. I also extend Lave and Wenger's work by illustrating how stewarding the community periphery happens in FETPs.

Chapter Seven: Discussion

In this chapter, I discuss the implications of the research conducted for this thesis by exploring four questions: 1) How can FETPs better facilitate learning based on the findings of this thesis? 2) Why was Lave and Wenger's framework effective for explaining FETP learning while other established theories were less so? 3) How did the methods shape the research findings? and 4) How can one facilitate a critical reference group (CRG) (Wadsworth, 1998) for similar research? The chapter then outlines practical implications for FETPs, public health workforce development, and the professional learning community before concluding with recommendations for next steps.

Terminology

The reader may notice overlapping and evolving terminology in this thesis, which I want to address.

— **Applied epidemiology** and **field epidemiology.** According to Koo and Thacker (2010), applied epidemiology is distinct from academic epidemiology in several characteristics, such as that it is more urgent, service-oriented, and practical. Field epidemiology falls within applied epidemiology. The key distinction of *field* epidemiology is that it refers to acute problems, while *applied* is the broader term including 'application and evaluation of epidemiologic discoveries and methods in public health and health care settings to improve health' (Koo & Thacker, 2010, p. 738). I began the thesis using the term *applied epidemiology* to be more inclusive, especially to the Australian FETP—ANU's Master of Applied Epidemiology. Most people in the FETP community, however, use the term *field epidemiology*. So, I transitioned to using that term to remain relevant to the researched and target community.

— **Advisors, mentors, trainers,** and **facilitators**. FETP relies on mentored, supervised learning. Programs refer to the professionals fulfilling those roles as mentors, supervisors, facilitators, or trainers, often interchangeably. The individual fulfilling these roles often performed all four of those functions. I began the thesis using the simple distinction 'trainer' and 'trainee'. In the protocol for the main study (Chapter 4), I write that a 'trainer' will be anyone recognised by the respective FETP as a person who designs or delivers an activity intended to change the knowledge, skills, awareness, attitudes or behaviours of trainees. By the time that I arrived at the findings of the main study, I felt that the individuals performing these roles were doing more than training (a fact that will become clearer in Chapter 6). So, I reached into the history of FETP and found the term 'advisor'. When US CDC began setting up FETPs around the world, they often installed a Resident Advisor (RA):

> The RA is an experienced applied epidemiologist, usually a graduate of CDC's EIS or another FETP, who is assigned to the FETP to help guide training and provide technical assistance. They often serve as the primary technical supervisor for the fellows during the first years of the program. They provide technical assistance in developing training materials, teaching and mentoring fellows, and consulting on priority public health issues (Jones et al., 2014, p. 4).

Throughout this thesis, *mentor*, *trainer*, *facilitator*, *supervisor*, and *advisor*, mean the same role, that of *advisor*.

— **Trainees, fellows, officers,** and **scholars**. In the protocol for the main study (Chapter 4), I describe trainees as 'anyone enrolled in a participating programme during the study period'. FETPs refer to these individuals, i.e., the ones learning field epidemiology, by different names like 'scholars' in Australia's MAE, 'officers' in the USA's Epidemic Intelligence Service, and 'fellows' in Japan's FETP. For simplicity, I have used the term 'trainee' throughout this thesis.

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Chapter 2 COVID-19 AND THE NEED FOR RESEARCH INTO FIELD EPIDEMIOLOGY LEARNING

I join the small room [. . . where two trainees] are on the left of the table and [two advisors] are on the right. They have already begun [the meeting. . .] discussing preparations for the outbreak investigation where they will go tomorrow, an investigation of [MPox spreading] in a psychiatric ward.

—Field notes, participant observation, Japan.

I began my doctoral candidature in October 2021, as the COVID-19 Omicron variant was spreading through the world. By then, the pandemic had underscored the importance of field epidemiologists. More of them might have meant a faster, more effective response, but rapid expansion of training programs risked compromising training quality.

Even before COVID-19, the field epidemiology community was pointing to concerns with training. For example, concerns with decreasing program quality due to complacency as programs matured, changes in ministry and donor interest, and program expansion or decentralization of training led US CDC to develop a standardized FETP curriculum (Traicoff et al., 2008). More recently, such concerns led to the development of a global field epidemiology roadmap (The Task Force for Global Health, 2018). The experts who developed the roadmap cited specific apprehensions:

- Assuring the quality of programs and graduates given the diverse contexts of FETPs.

- Adapting and enhancing FETP given changing technologies, analytic techniques, and global health security needs.
- Enhancing training and training modalities for both trainees and graduates.
- Expanding the scope of FETP to address emerging areas like One Health and socio-economic determinants of health while remaining true to the original mission.
- Developing competencies and systems for cross-border field epidemiology during crises.

Amid the heightened political awareness of health security, I, with others at the ANU Research School for Population Health (now, National Centre for Epidemiology and Population Health), sought to focus attention on targeted investments. Drawing on the literature and our collective experience, I submitted a 1500-word perspective to the *Bulletin of the World Health Organization*. Four days later, the editors requested that I condense the manuscript to an 800-word editorial for publication a month later 'given the importance of the topic' (Gollogly, L., personal communication, 3 June 2022).

This chapter presents the published editorial. In it, I identify three key challenges, caution against two risky approaches, and recommend five actionable steps to strengthen applied epidemiology capacities. Among the challenges, I note concerns with training quality. One recommendation that I make is to ensure training approaches align with goals, reviewing competencies and engaging learning science professionals to develop training that matches trainees' learning needs and styles.

In June 2024, *ANU Policy Brief* republished the key elements of this manuscript, which is available here.

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COVID-19 and investment in applied epidemiology

Matthew Myers Griffith,[a] Amy Elizabeth Parry,[a] Tambri Housen,[a] Tony Stewart[a] & Martyn D Kirk[a]

Now is the time to invest in applied epidemiology. Applied epidemiology is the intelligence arm of health emergencies: it provides information on a pathogen's movements and ways to stop it. Most countries had applied epidemiologists when the coronavirus disease 2019 (COVID-19) appeared; yet we needed more applied epidemiologists with better training, and higher government regard. The pandemic caused millions of deaths and social disruptions, so governments must invest in applied epidemiology before the next one.

Applied epidemiologists inform decision-making to improve population health. They help control epidemics by modernizing disease reporting, improving disease indices, informing clinical examination and treatment, advising on laboratory testing and recommending control measures.[1] Whereas academic epidemiologists value analytic rigour and use high-quality data from controlled circumstances, applied epidemiologists value urgency, speed, practicality, responsiveness and impact; they use real-life data from surveillance and field investigation.[2]

When COVID-19 appeared, too few applied epidemiologists (including field epidemiologists) were working in the field. The World Health Organization (WHO) sets a target of one field epidemiologist per 200 000 population. This target has limitations, such as no standard definitions or job classifications, but helps direct efforts and identify challenges to progress.[3] A graduate of a field epidemiology training programme has become the proxy for field epidemiologist. Globally, 86 of these programmes existed in 2021,[4] meaning that many countries could not produce their own graduates. Even where programmes existed, not all their graduates worked in the field. For example, the Jordan training programme had graduated 63 residents as of 2017, making it one of the few countries in the region to meet the WHO target, yet only 39 of them were working as government epidemiologists.[5] Papua New Guinea had graduated 81 as of 2018 (1.8 per 200 000), but over half of its 89 districts lacked a graduate.[6]

Furthermore, not all graduates acquire competencies for a health emergency such as COVID-19. Global partners and national governments have spread the Epidemic Intelligence Service training approach around the world since the 1970s. In 2003, the United States Centers for Disease Control and Prevention made a standard curriculum to improve consistency across programmes, among other reasons.[7] In 2019, funders, implementers and stakeholders of these programmes noted that expansion and diversification brought challenges for assuring quality and updating curricula.[8] A survey of applied epidemiologists in 64 countries shows gaps in data analysis, epidemiology methods and social and communication skills.[9]

Government regard affects the number of competent applied epidemiologists working in the field. Governments can support training programmes and facilitate graduates to work in public health. Yet, in 2019, slow in-country institutionalization of training programmes and a lack of career paths for graduates surfaced as key challenges to epidemiology capacity.[8] Without funding, programmes seek external support, which comes with demands that may not meet national needs. Without career paths, recruits do not join and graduates go to private institutes or abroad.

Insufficient numbers, inadequate training and low government regard reduce applied epidemiology's capacity to investigate epidemics and inform decisions to control them. Governments that seek informed, timely decisions to prevent epidemics from becoming pandemics must invest in applied epidemiology. We urge governments not to create a training programme where one already exists. We caution against investing in data technologies while the people who collect, report, interpret and strengthen data lack the numbers, training and recognition to do it. Instead, we recommend five actions.

First, establish pathways for applied epidemiologists to work in government public health. Career paths attract talent and convert investment in training into investment in the public's health. Governments should classify epidemiologists in human resources schemes and clarify pathways for promotion.

Second, institutionalize applied epidemiology training programmes. National funding avoids incompatible external demands and political cycles. Governments should secure line-item budgets for their training programmes.

Third, inform epidemic and pandemic decision-making with applied epidemiology. Applied epidemiologists interpret epidemic information and inform decisions. Governments should appoint them to advisory roles, involve decision-makers in their training programme activities and facilitate trainees to investigate local outbreaks.

Fourth, establish training programmes where they do not yet exist. At minimum, every 200 000 people should have a trained, competent field or applied epidemiologist to detect and investigate epidemics. Governments should work with partners to build programmes that meet local needs.

Fifth, ensure training approaches fit the purpose. Investment must produce a competent workforce that serves populations and informs decision-makers. Governments should review training competencies – considering the lessons of COVID-19 – and engage learning science professionals to develop training that matches trainees' learning needs and styles.

WHO advocates that we have the duty to do things differently, to invest to create fairer and more resilient health systems.[10] Applied epidemiology is an intelligent investment. ■

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Available at: https://www.who.int/publications/journals/bulletin

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Chapter 3 THE FOUNDATIONAL FETP WITH AN UNEXPECTED LEARNING APPROACH

[We] throw them overboard. See if they can swim, and if they can't throw them a life ring, pull them out, and throw them in again.... As soon as they have met one epidemic problem and licked it, they are as different as they can be.

—Alexander Langmuir, founder of the U.S. Epidemic Intelligence Service, quoted in Etheridge (1992), p. 48.

After urging the global community to invest in field epidemiology training, I sought to identify how I could contribute to such investment with this thesis. I attempted a scoping review of training and learning in field epidemiology, but the literature was so limited that I had to abandon the review. Many people had written about FETP, but none that I could find had examined learning processes. They published program evaluations and described program structures, but none exposed the "black box" of learning, i.e., its complex internal workings remained hidden.

Instead, I began assembling those program descriptions chronologically, hoping to compile a useful description of FETP training approaches beyond 'learning by doing'. If we understood the training approaches in detail, I reasoned, we could infer the philosophy of learning in FETP. The program descriptions came mostly from the introductions of published manuscripts. They were insufficient.

I returned to the advice of a supervisor to explore Alexander D. Langmuir, founder of the U.S. Epidemic Intelligence Service, the first FETP. A posthumous hagiography (see *American Journal of Epidemiology,* 1996, Vol. 144, No. 8 suppl.) provided insights into Langmuir's training approaches as former trainees recounted their experiences.

While I read them, familiar learning theories came to mind: Kolb's (2015) experiential learning and Knowles's (1989) andragogy. I began systematically comparing Langmuir's program with those theories, hoping to frame the foundations of FETP in the language of learning and suggest something about learning processes. I also compared Freire's (2000/1968) problem-posing education, Mezirow's (2009) transformative learning, and Lave and Wenger's (1991) communities of practice, too. Ultimately, I found stronger alignment with Knowles, Kolb, and Lave and Wenger.

In May 2023, I submitted a manuscript of these comparisons to the *International Journal of Lifelong Education*. It was published in January 2024.

This chapter presents the published manuscript. In it, I illustrate the first FETP's approach to learning and then demonstrate how it aligns with Knowles's, Kolb's, and Lave and Wenger's work, revealing constructivist, situated, and humanist underpinnings. Such alignments, I argue, are unexpected for the time and place of that program, but, I also argue, they fit population health and help to explain the enduring global spread of FETPs. To close the manuscript, I raise questions for research about the role of culture, gender, non-human actors, and contemporary learning theories in shaping FETPs.

Though I did not recognize it then, this manuscript became foundational for this thesis, demonstrating the contribution of two critical elements: qualitative research on learning and Lave and Wenger's explanatory framework. Furthermore, the manuscript sets FETP in the parlance and academic field of learning, providing FETP with a complementary language to communicate its importance and impact.

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Case study: adult learning and public health—a foundational training programme in field epidemiology with lessons and opportunities for collaboration

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ABSTRACT

This article explores the first field epidemiology training programme (FETP) through a case study to understand its approach to learning and education. Field epidemiologists deploy to outbreaks to investigate, control, and prevent future epidemics and pandemics. Since the 1950s, they have learned their trade through FETP. FETP arose at a paradigmatic crossroads, has endured for seventy years, and is now delivered in over ninety countries. COVID-19 has highlighted the urgency for re-thinking learning in the health sector, hence the analysis of this case can inform FETP, public health, and the adult education field. Inductive content analysis of this case using published accounts from the programme designer-leader and participants suggests the programme's approach to learning reflected Knowles's andragogical assumptions, Kolb's experiential learning cycle, and Lave and Wenger's legitimate peripheral participation in communities of practice. Alignment with such influential contributors to the field of adult learning clarifies the programme's paradigm and explains its endurance. Now, given the lessons of COVID-19, critical learning approaches are needed to enable field epidemiologists to engage issues of culture and power as they investigate epidemics. Recent adult learning theories offer opportunities for adult educators to collaborate with public health programmes. COVID-19 urges that we do not hesitate.

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Introduction

COVID-19 required extraordinary efforts from everyone, not least the individuals responsible for determining how the virus spread. These people, primarily field epidemiologists, headed into situations with uncertain circumstances, high stakes, and incomplete information to identify who was infected, obtain information, analyse it, and advise decision-makers how to control COVID-19. Doing so required combining the tools of epidemiology (statistics, survey methods, study design) with an ability to work in teams, across cultures, across disciplines, and in high-stakes stressful environments.

Generally, 'field epidemiology' refers to using epidemiologic tools to investigate urgent public health problems and recommend actions to control or prevent them (Goodman & Buehler, 2008). The core mechanism for training field epidemiologists is the post-graduate, field epidemiology

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training programme (FETP[1]). FETP provides a 'mentored, learning-by-doing approach that emphasises fieldwork', combining face-to-face modules with field training (TEPHINET, 2023a).

FETP dates to 1951, when Alexander D. Langmuir, leveraging the need to prepare the U.S. for biological warfare, created the Epidemic Intelligence Service (EIS) at the Communicable Disease Center[2] (CDC) in Atlanta (Langmuir & Andrews, 1952). He aimed to develop national epidemic[3] expertise by turning medical clinicians into field-savvy epidemiologists, transforming their focus from the patient to the population (Schaffner & LaForce, 1996, p. S17). The first EIS class had 22 physicians and one sanitary engineer (Etheridge, 1992, p. 43). Today, the U.S. programme has over 4,000 alumni, including leaders of the U.S. CDC, U.S. state health departments, schools of public health and medicine, and the World Health Organization (Centers for Disease Control and Prevention, 2022; So et al., 2022). The second FETP opened in Canada in 1975, and then throughout the 1980s – with the support of the World Health Organization and CDC – FETP launched in Thailand, Indonesia, Mexico, Taiwan, Philippines, Peru, and Saudi Arabia (White et al., 2001), as countries 'copied' the US programme (Foege, 1996, p. S13). Today, 91 FETPs operate in more than two-thirds of the world's countries and territories (TEPHINET, 2023b), yet no exploration of FETP learning approaches has been published. We thus set out to explore the learning approaches in the foundational FETP through a case study.

We recognise at least three factors underscoring the 'learning potential' (Abma & Stake, 2014/2000) of the foundational FETP as a case for study. First, FETP's longevity and spread across the globe must hold lessons for adult learning programmes. For more than 70 years, FETP has trained adults in field epidemiology, developing technical experts as well as leaders. As countries 'copied' FETP across the globe into their distinct contexts, adaptations occurred yet core learning principles, process, and activities have persisted. A deeper understanding of the foundational approach to learning could reveal these core elements and inform questions on standardisation versus contextualisation.

Second, the foundational FETP arose at a paradigmatic crossroads. American behaviourism dominated U.S. learning approaches from the 1910s to the 1970s (Illeris, 2018), an approach based in positivism or what Hodge and colleagues call 'scientific' learning approaches (2022). These approaches, like Science, held that Truth was discoverable and measurable through the experimental method and that behaviour change was possible through conditioning. (Epidemiology, it is worth noting, is a science that attempts to *verify* outbreaks through quantitative methods.) Around the same time, however, constructivists were refocusing learning from teacher- to student-centred. For example, Piaget (1947/1950, 1936/1952) was being translated into English, while American educators such as Lindeman (1926), Dewey (1938), and Rogers (1951) were establishing the roots of what would become humanist learning – the 'process of coming to be' (Hodge et al., 2022, p. 400). Constructivists hold that rather than discovering Truth, learners and educators construct knowledge as their mental structures interact with social and physical environments through experience. Educators seek to create quality experiences that facilitate learning. Although social constructivist ideas would not appear in advanced forms in English for several decades (Freire, 1970; Jarvis, 1987; Lave, 1988; Lave & Wenger, 1991), their core assumptions are congruent with the epidemiologic perspective of health and disease as an outcome of the interactions between populations and their environments. Accordingly, how this programme approached learning at this crossroad could contribute to theoretical questions raised in this journal by Gouthro (2019) and Hodge et al. (2022).

Third, COVID-19 has emphasised the need for population-based health approaches (den Broeder et al., 2022; Rosenbaum, 2020). Epidemiologists, however, have understood the population-nature of disease since founding the discipline. 'Epidemiology' is the study of health events in populations, and the term 'epidemic' derives from the Greek *epi* (upon) and *demos* (people) (Porta, 2014, pp. 95–96). Indeed, a stated aim of the foundational FETP was to transform the perspective of medical doctors from the individual to the population. We believe that how this programme approached learning for population-based health could guide other adult learning programmes throughout the health field.

Thus, the purpose of this case study is to better understand the approaches to learning employed in the foundational FETP and through that understanding suggest lessons based on the case's learning potential: 1) What can the learning approaches suggest about FETP's longevity and dissemination? 2) What does the programme's learning paradigm suggest about the paradigmatic crossroads within which it arose? and 3) How can the foundational FETP's learning approaches inform adult learning programmes for the population-health field?

What follows is our exploration of the foundational FETP through a case study that focused on its approach to learning. We first describe our case study method. Next, we present the case followed by our analysis, which proposes that the core elements of three seminal learning theories align with the case. We suggest that this alignment helped the programme endure and spread over seven decades. Finally, we identify areas of research in adult education that could better prepare field epidemiologists for future pandemics and with support from the field of lifelong education and learning.

Materials and methods

We approached the case study from the constructivist paradigm, aiming for better understanding of the adult learning approaches in the foundational FETP. We focused on identifying which learning theories and paradigms align with the programme's approach to learning, then exploring if or how those theories and paradigms may explain the programme's longevity and dissemination to diverse contexts.

The case (unit of analysis) was the initial FETP – the U.S. EIS during the time that Langmuir was in charge (1951–1970). Given that more than 50 years have elapsed, we used publicly available documents describing the programme and the perspectives and experiences of its leader and participants.[4] We explored the case through content analysis, following Patton's description: 'any qualitative data reduction and sense-making effort that takes a volume of qualitative material and attempts to identify core consistencies and meanings' (Patton, 2015, p. 541). Specifically, we used an inductive process, reviewing the text repeatedly to discover consistencies between the programme and known learning theories. Once a theory was suggested, we read the text again seeking consistencies between the core elements of that theory and the descriptions in the text. Testing the fit of the theory to the programme is beyond the scope of this work. Instead, we reasoned that any programme components that aligned with core elements of established learning theories could be considered important for explaining the programme's longevity and dissemination.

The case: EIS (1951–1970)

To recruit 'officers' (programme trainees) into EIS, Langmuir targeted departments of medicine, paediatrics, and preventive medicine in medical schools, as well as departments of epidemiology in schools of public health. During the case-study period, EIS graduated 673 officers, the majority of which were physicians (79%), followed by veterinarians (10%) and statisticians/demographers (6%) (Thacker et al., 2001). Most of these officers were White and male.[5]

The training programme followed a medical model with an introductory course and an internship. In the month-long course,[6] Langmuir's learning activities comprised example-based lectures in the mornings and discussion-based case studies in the afternoons. To engage learners in the 'lectures', Langmuir worked through the situation, problem, and data of specific epidemics so that learners would come to understand the principles of epidemiology. He believed that students should 'be shown the tools of the epidemiologists and be taught to use them, rather than stressing subject matter that can readily be derived from texts' (Langmuir, 1964b, p. 46). Langmuir would enliven these lectures by linking them to concurrent incomplete epidemiological investigations. For instance,

> We still remember his orchestrating a 'late breaker' during the 1966 EIS course. [Two officers] were teamed in investigating a salmonella outbreak that ... had been traced all the way to a fish processing plant ... in the Northwest Territories, Canada. Langmuir had arranged for a short-wave radio hookup to be piped into the lecture room and had the team in the field report periodically on its findings as the investigation progressed. In voices made scratchy by the short-wave transmission, [the officers] described the desolation of northern Canada and what information they had acquired to date. Langmuir quizzed the team vigorously and quickly honed in [*sic*] on the observation that the sewage-contaminated water used by the processing plant offered obvious opportunities for contamination of the fish. The scene was reminiscent of a vintage movie with Langmuir on stage holding a microphone, relaying questions from the class, and concluding with 'good luck' and then 'over and out'. This bit of epidemiologic theatre worked just as planned, drawing the recruit audience right into the action. (Schaffner & LaForce, 1996, p. S18)

Even with such a passion for theatrical lectures, Langmuir's preferred approach to learning was the case study. In describing his own education in epidemiology, he remarks,

> Really, part of the course was the lab—the epidemic problems that we were given, the basic records to put together and to analyse and to get rates and the right denominators and draw the inference—what is the mode of spread? And what is the basis of this? And this is the case study method that [Wade Hampton] Frost develops, which I still think is the best method of teaching and which I've used all the rest of my life and honed to the best of my ability. (National Medical Audiovisual Center, 1979, 00:14:00)

For EIS, Langmuir employed a particular case-study method. He used what he called 'blind' problems, which withheld the diagnosis of the disease causing the epidemic until the end. 'blind' problems were advantageous in that '[s]uspense is created, the intellectual challenge is enhanced, and the student is forced to reason from purely epidemiological evidence unencumbered by his [*sic*] preconceived notions about the disease in question' (Langmuir, 1975, p. 253). These case studies included seminar discussions of the problem, in which 'instructors can emphasise many epidemiological principles, introduce many analogous situations, and develop, test, accept or reject many hypotheses purely on the basis of the epidemiological evidence' (Langmuir, 1975, p. 253). Langmuir recognised that this process challenged and engaged learners:

> To some students the first reaction is 'impossible', 'unfair', 'we are not told enough information', etc. Soon, however, to most students, the game becomes intriguing. Although many hypotheses cannot be positively rejected, they become hemmed in by highly specific and improbable conditions, the existence of which could be promptly tested by a few questions to an informed local official. The seminar leader may serve this function but his answers should be brief. The excitement of hot pursuit of the quarry can often be generated, thus simulating in condensed version the real life situation of an epidemic investigation. (Langmuir, 1975, p. 255)

Langmuir trained second-year officers to lead these seminar discussions believing 'one learns more from a colleague only slightly more experienced than from a senior staff member' (Langmuir, 1980, p. 472). Graduates acknowledge that this approach 'lent veracity' to the course:

> It was in these small sections that we tackled the data from actual outbreaks that had been fashioned into epidemiologic teaching exercises; they were the heart of the course. In these intimate give-and-take sessions, EIS veterans just back from field assignments taught not only numerical epidemiology but also the lore of how investigations were actually conducted on a daily basis. These experienced EIS officers emphasized ingenuity, flexibility, and resourcefulness as well as the palpable delight of analyzing a real problem through to its solution. (Schaffner & LaForce, 1996, p. S17)

Although Langmuir appears to have put much energy into the introductory course, he emphasised that it was only an introduction to the discipline. 'Thus prepared, EIS officers were to really learn applied epidemiology during their two-year assignments under the guidance of experienced epidemiologists ("learning by doing")' (Schaffner & LaForce, 1996, p. S19). The assignments were paid internships at CDC, health departments, or university research institutes in which officers addressed public health problems, such as strengthening or creating surveillance systems and responding to epidemics.[7]

> Our training was truly in the classic mode of an apprenticeship. The Epidemiology Branch was confronted with problems and challenges, and we were put to work assisting Langmuir in dealing with them. We learned

> on the job, with little time spent on formal didactic training. Whatever was neglected in the way of formal training was more than compensated for by the drama of dealing with public health problems at a local and national level. Imbued with the excitement of investigating an outbreak, the power of the discipline became apparent. It was sufficient to absorb the methods as the investigation unfolded and to defer systematic schooling to a later time. (Nathanson & Alexander, 1996, p. S34)

Langmuir believed that such on-the job practical training was essential for all large health organisations for pragmatic and learning reasons:

> Too many now blithely rely on the academic institutions to deliver fully trained products for them to employ, with too little obligation to assist in the recruiting and training of suitable candidates. [Also], many academic institutions have too limited outlets for the integration of bona fide practical field experience with their sometimes ivory tower, theoretical approaches. (Langmuir, 1980, p. 477)

To ensure that officers had ample opportunities to learn in the field, Langmuir created a simple intra-governmental administrative device – the Epidemic Aid Memorandum – that allowed states to request CDC support to investigate anything resembling a potential epidemic. 'Each epidemic aid call was an adventure and a training experience, even the false alarms' (Langmuir, 1980, p. 473). For these 'training experiences', officers went without supervisors and called headquarters regularly to discuss their data, hypotheses, and developments; hear critiques of their investigations; exchange ideas; and receive guidance (Brachman, 1996). Two alumni reflect on this bold approach to training:

> Even on reflection, the epidemic aid mechanism appears audacious and risky. Novice epidemiologists were sent into the maw of ongoing epidemics with the reputation of a fledgling federal institution precariously balanced on their shoulders. Officers often were seen reading furiously about the putative disease in question while in transit heading toward the epidemic. Langmuir, however, had great faith that people would be able to do things well that they had not done before. This trust was empowering and provided the milieu in which already strongly motivated individuals performed to high expectations. However, enthusiasm and intensity can careen off course, so Langmuir also believed strongly in mentoring to provide checks and balances. No one was sent into the field without supervision from their home base. (Schaffner & LaForce, 1996, p. S19)

Langmuir did not forget the real nature of these training opportunities – he required all officers to leave recommendations with local decision-makers to control the outbreak or prevent recurrences before returning to headquarters. When they did return, the officers reviewed (or defended) the investigation with Langmuir and staff, sometimes resulting in a return to the field (Brachman, 1996; Schaffner & LaForce, 1996). An additional step of reflection on the experience followed:

> A final report had to be written that defined the problem, described the methods of the field investigation, displayed the epidemiological analysis, discussed the results, and presented the final conclusions and recommendations. These reports were a fundamental feature of the training program, obliging the officers to hone their epidemiologic judgment, thereby documenting that they had sufficient data to justify their public health decisions. (Schaffner & LaForce, 1996, p. S19)

After multiple rounds of revisions, officers submitted these reports to peer-reviewed scientific journals.[8] In this way, Langmuir scaffolded learning in the field and facilitated interdisciplinary learning, networking, and impact.

Finally, Langmuir incorporated an annual conference that was 'modelled closely on national scientific research meetings and ... designed explicitly as an essential training experience for his fledgling epidemiologists' (Schaffner & LaForce, 1996, p. S19). Officers competed with one another and with alumni to have their papers accepted into the conference. If accepted, they presented an investigation with ten minutes for exposition and ten for discussion. The audience included peers, seniors, and alumni, and the 'peer pressure for excellence in presentation [was] a key feature of the discussion' (Langmuir, 1980, p. 474). EIS funded the alumni to attend so they would remain current on epidemiologic advancements while strengthening network cohesiveness. Langmuir observes that the conference 'had a major effect on the educational development and cohesiveness of EIS officers' (Langmuir, 1980, p. 474).

Case study analysis

What is apparent from the case study is that Langmuir viewed learning as a serious endeavour requiring intentional design and dedicated implementation. Beyond lectures, case studies, and assignments, intentional training devices are evident: the Epidemic Aid Mechanism, the post-investigation report, the annual conference. Langmuir also demonstrated his dedication to learning implementation by training second-year officers to be instructors, requiring them 'to devote full time to the course, beginning three weeks before the recruits arrived' and thus 'the EIS course was a training ground for teachers of epidemiology' (Langmuir, 1980, p. 472). Further, Langmuir shared his perspective on effective learning with other medical educators through speeches and publications (see Langmuir, 1964a, 1964b, 1975). In her history of US CDC, Etheridge devotes a chapter to Langmuir's EIS. Her analysis of Langmuir's oral history notes how he revelled in the excitement of working with the programme's bright young men (and later women). She acknowledges that for the officers, the experience was a challenge:

> As fast as Langmuir could, he sent them to investigate an epidemic. '[We] throw them overboard. See if they can swim, and if they can't throw them a life ring, pull them out, and throw them in again . . . . These men [*sic*] become different. As soon as they have met one epidemic problem and licked it, they are as different as they can be. Fifty per cent of them stay in the field'. (Etheridge, 1992, p. 48)

In the following sections, we argue that Langmuir adopted a learning approach that diverged from the prevailing educational practices and the paradigmatic assumptions of epidemiology. We begin by proposing that Langmuir's methods echo fundamental aspects of seminal adult learning theories, which in turn illuminate and clarify the programme's key elements. Subsequently, we contend that this distinctive approach not only sheds light on the programme's longevity but also its suitability for effective learning in population health.

A process-focused learning approach

It is evident that Langmuir organised the foundational FETP as a process to facilitate learning rather than a space to deliver content. The intentional training devices named above, which could not be considered content delivery mechanisms, are examples. Moreover, instead of subject-based lectures, Langmuir's approach was to walk through the problems of specific epidemics with the learners and then ask them to engage with the data in case studies. Even the approach to biostatistics 'was grounded on the case-study method' (Stroup & Smith, 1996, p. S31). 'Langmuir believed that by working through the actual data of a specific epidemic one would best come to an understanding of principles' (Schaffner & LaForce, 1996, p. S17).

This focus on process aligns with Knowles's andragogical assumptions:

> [T]he basic format of the andragogical model is a process design. The andragogical model assigns a dual role to the facilitator of learning (a title preferred over 'teacher'): first and primarily, the role of designer and manager of processes or procedures that will facilitate the acquisition of content by the learners; and only secondarily, the role of content resource. The andragogical model assumes that there are many resources other than the teacher, including peers, individuals with specialized knowledge and skill in the community, a wide variety of material and media resources, and field experiences. One of the principal responsibilities of the andragogue is to know about all these resources and to link learners to them. (Knowles, M. S., & Associates, 1984, pp. 13–14)

Andragogy, as the science of learning and education among adults, has roots at least as far back as Hellenistic and ancient Jewish cultural circles with its foundational ideas – the philosophy of lifelong education – stated by Comenius in Pampedia (Savicevic, 2008). Knowles derived his assumptions about adult learners from his work in vocational training and from the work of Lindeman, Tough, Bruner, and Dewey, among others. Initially, he contrasted pedagogical (i.e. child-teaching) and andragogical (i.e. adult-teaching) assumptions but later posed them as a spectrum that could apply to adults and children, depending on the situation.

The six assumptions (1989, pp. 82–85), presented here in italics, underscore and help explain elements of the foundational FETP. For instance, because *learners need to know why they need to learn something before undertaking to learn it*, Langmuir invited recruits to the annual conference to 'gain an in-depth understanding of the kind of programme they are joining and the types of problems that they will soon be encountering' (Langmuir, 1980, p. 474); because *learners have a self-concept of being responsible for their own lives and need to be seen and treated by others as capable of self-direction*, Langmuir sent officers into the field without supervisors; because *learners have a greater volume and different quality of experience* [compared to children], *with a wide range of differences and learning across any group*, Langmuir preferred case-study seminars, in which learners must discuss their perspective of the problem and suggest solutions based in their prior experience; because *learners become ready to learn those things they need to know or to be able to do to cope with their real-life situations*, the lectures and case studies centred on epidemics rather than endemic disease, 'which was no accident' because epidemics 'were exactly the sort of problems that [the] recruits anticipated facing' (Schaffner & LaForce, 1996, p. S17); because *learners are life-, task-, or problem-centred in their orientation to learning*, Langmuir focused activities on the solving of epidemic problems; and because *learners are more responsive to intrinsic motivators than extrinsic motivators*, the programme required officers to compete for their work to be presented at the annual conference.

An experiential learning approach

Our analysis of the foundational FETP surfaced a preference for learning from experience, with organised activities that required officers to consider and reflect on their experiences to facilitate learning. For example, when officers returned from the field, they joined Langmuir and staff to review or defend their investigations. They also wrote a report of the investigation, 'obliging the officers to hone their epidemiologic judgement' (Schaffner & LaForce, 1996, p. S19). Case studies too, when discussed in seminar, require reflection on the scenario to develop hypotheses, a step that Langmuir emphasised with 'blind' problems that forced learners 'to reason from purely epidemiological evidence unencumbered by [their] preconceived notions' (Langmuir, 1975, p. 253), thus requiring them to reconsider their experience and knowledge.

Although notable theorists have argued for learning from experience (Dewey, 1938; Lewin & Cartwright, 1951; Piaget, 1952), the intentional efforts to structure the reflection on experience to arrive at principles aligns with Kolb's experiential learning theory (Kolb, 1984, 2015). Kolb drew on Dewey, Lewin, and Piaget, among others, to develop his theory, which he describes:

> Learning is defined as 'the process whereby knowledge is created through the transformation of experience'. Knowledge results from the combination of grasping and transforming experience. Grasping experience refers to the process of taking in information, and transforming experience is how individuals interpret and act on that information. The experiential learning theory learning model portrays two dialectically related modes of grasping experience—Concrete Experience (CE) and Abstract Conceptualization (AC)—and two dialectically related modes of transforming experience—Reflective Observation (RO) and Active Experimentation (AE). Learning arises from the resolution of creative tension among these four learning modes. (2015, p. 51)

Kolb's learning cycle clarifies and emphasises the selection and sequence of the foundational FETP activities. For instance, alternating morning lectures and afternoon case studies reflects the dialectic tension between CE and AC that must be resolved through reflection and experimentation. This is in stark contrast to a content-based approach that typically provides a week of lectures, one subject after the other, presenting concepts upon concepts without the opportunity to experiment with them. In another example, the investigation of epidemics in the field (CE) required reflection (RO) through dialoguing with supervisors and writing reports – 'a fundamental feature of the training programme' (Schaffner & LaForce, 1996, p. S19) – thereby transforming experience into knowledge as abstract conceptualisations (AC).

An approach situated in practice

A preference for learning in practice is also evident in this case. Langmuir stressed that real learning occurs not in the introductory course but in the two-year assignments. Even in the introductory course, however, he contextualised lectures with officers reporting conditions from the field in which they were investigating. In FETP case studies, 'the lore of how investigations were actually conducted on a daily basis' became a fundamental part that second-year officers leading the discussions provided (Schaffner & LaForce, 1996, p. S17).

In this preference, we recognise the work of Lave and Wenger (1991):

> ... legitimate peripheral participation as the core concept of relations of learning places the explanatory burden for issues such as 'understanding' and 'levels' of abstraction or conceptualization not on one type of learning as opposed to another, but on the cultural practice in which the learning is taking place, on issues of access, and on the transparency of the cultural environment with respect to the meaning of what is being learned. (pp. 104–105)

Here, learning is not about internal processes for obtaining external knowledge. It is a process situated in and inseparable from the everyday activities of a community of practitioners; a process that continually redefines the relations, identities, meaning, knowledge, learning, and practice of that community; a process Lave and Wenger call legitimate peripheral participation in communities of practice (1991). In this process, learners come initially to the periphery of a community of practitioners and interact with its learning curriculum – the decentralised field of learning resources situated in everyday practice – and then move centripetally towards full participation in the community's sociocultural practice, mastering knowledge and skills as they interact with the learning resources, thereby changing the socially constructed relations, identities, meaning, knowledge, etc. of that community.

This lens of legitimate peripheral participation in communities of practice both explains and emphasises the essential role of components of the foundational FETP. Firstly, if newcomers are sequestered from legitimate participation, their self-identity becomes an object of change: the learner mediates and distorts learning through a view of self as object (Lave & Wenger, 1991, pp. 111–112). In contrast, the foundational FETP moved newcomers quickly from the introductory course into paid assignments, where they took on legitimate responsibilities as novice epidemiologists, which would allow central participation in the community of practitioners to motivate learners' subjective intention to learn. Indeed, there was no effort to even 'orient recruits to the programme of the CDC or to the organisation of the Public Health Service because it was thought that such knowledge is better acquired on the job than from lectures or seminars' (Langmuir, 1980, p. 472). Secondly, without cultural identity and mature practice surrounding the activities in which newcomers participate, learning can become commoditised: the value of learning for exchange outweighs that of learning for use (Lave & Wenger, 1991, pp. 111–112). Thus, bringing to life the tools and mental processes of the old epidemiology masters during lectures, arranging interactions with second-year officers in case studies, placing newcomers in assignments with experienced epidemiologists, and bringing alumni to the annual conference emerge as important elements of the foundational FETP.

A constructivist humanist-situated approach to learning field epidemiology

So far, we have illustrated how the foundational FETP aligns with Knowles's andragogical assumptions, Kolb's experiential learning cycle, and Lave and Wenger's legitimate peripheral participation in communities of practice, and we have employed those theoretical elements to underscore and explain important components of the programme. Here, we suggest that such alignment with influential contributors to the field of lifelong learning could explain the programme's longevity.

To begin with, Merriam (2017) identifies Knowles's work among three[9] foundational theories of adult learning. Even critics of Knowles's work (Brookfield, 1986; Jarvis, 2006)

assert that though the assumptions are not a theory of learning, they are useful for guiding educational practice. On Kolb, Merriam and Baumgartner (2020, p. 199) propose his is the best-known theory of experiential learning. While Tennant critiques Kolb's work extensively, he concludes by appraising it as 'an excellent framework for planning teaching and learning activities' (Tennant, 2006, p. 91). Illeris (2018, p. 97) argues that Lave and Wenger brought attention to the social dimension of learning, while Patel (2018) states that their work has become crucially important for educational studies and historically significant for addressing apprenticeship in learning studies. Thus, these theories have been judged useful for structuring learning activities and (perhaps because of that) have been cornerstones for advancing the field of lifelong learning. That the foundational FETP employed similar assumptions, principles, and processes can partially account for its longevity and spread. FETP and health programme designers may do well to overtly structure programmes around these assumptions, principles, and processes.

Moreover, the alignment with these theorists identifies the foundational FETP as operating from a constructivist paradigm based in humanist and situated learning. The humanists, such as Kolb and Knowles, drew on the humanist psychology of Maslow (1954) and Rogers (1951) to focus education and learning on self-actualisation and self-realisation, 'learning as the process of coming to be' (Hodge et al., 2022, p. 400). Situated learning similarly sits within the constructivist paradigm emphasising as it does that learning is not merely a cognitive activity but involves active participation in a specific social and cultural context. Considering that the officers in this programme were overwhelmingly medical doctors who – like Langmuir – would have been educated in the positivist sciences of physics, chemistry, biology, etc. and that epidemiology, though concerned with populations, comes from the positivist tradition that aims to *verify* outbreaks and *test* hypotheses with quantitative data, this finding is significant: despite the hierarchical nature of government, the backgrounds of Langmuir and the learners, the positivist and conceptual base of epidemiology, and the dominance of American behaviourism at the time, the foundational FETP oriented to the constructivist paradigm that was emerging, one that would take the central role in adult learning for decades. This finding suggests that Langmuir and by extension a foundational training programme for the core science of public health – epidemiology – perceived knowledge not as discoverable but as constructed. Rather than a positivist adherence to Truth, truths – at least in epidemiology – are constructed.

Within the constructivist paradigm is flexibility and adaptability to change across time, contexts, learners, and learning environments. This flexible and adaptable orientation to knowledge construction and to learning itself could have facilitated the programme to endure and spread to diverse contexts. The authors wonder if a behaviourist approach could have reached such lengths.

Learning within population health

Alignment with the core theoretical elements of Knowles, Kolb, and Lave and Wenger also helps to illuminate the approach to learning within a population health perspective. Starting with Lave and Wenger, we have suggested that promotion of legitimate peripherality was a principal element of the foundational FETP because it facilitated central participation to motivate officers' intention to learn and learning for use rather than as a commodity. This element becomes ever more important when considering – as COVID-19 highlighted – that populations and pathogens are ever-changing. Their interactions produce unique epidemics. Field epidemiologists can neither view themselves nor the populations they serve as objects of change but as co-constructors of knowledge. The pathogen is not hiding in the community for the epidemiologist to discover – the epidemiologist collaborates with the community to construct knowledge about the pathogen, its transmission in the population, and the solutions to controlling it. Indeed, epidemic responders must develop methodological and technical mastery as well as skills in communication and relationship building (Parry et al., 2021). Without

legitimate peripherality, sequestered learners might grasp the methods intellectually, but they would struggle to construct the tacit understanding and field capabilities required to apply them in diverse and fluctuating contexts.

Furthermore, without the centripetal movement of legitimate peripheral participation, more people may die. In population health, errors can cost peoples' lives. Newcomers must learn at the periphery, where 'tasks are short and simple, the costs of errors are small' (Lave & Wenger, 1991, p. 110). As central participation engages their intention to learn, centripetal movement drives them to complete tasks with and to the satisfaction of mature practitioners. In turn they partake in tasks requiring more time, effort, and responsibility. Thus, this process allows learning to occur while managing the risk of error on the populations served by the learners.

Yet, as Taber et al. (2008, p. 273) point out in their study on firefighters and paramedics, Lave and Wenger's theory does not account for novel situations. Emergency responders need to develop a 'feel for the game'. Here, we again highlight the importance of Kolb's learning cycle: by reflecting on stories, case studies, and the experiences acquired in the field, learners develop generalised concepts about 'the game'. When they compare these concepts with those of their peers and mature practitioners, they reinforce or alter their concepts for future application to novel situations. This process, akin to the experiential learning cycle, would have prepared field epidemiologists in the foundational FETP for novel contexts while initially keeping them at the periphery where the risks of error were lower. To put this another way, the officers, motivated to learn by central participation, spiralled through the learning cycle in situations from lesser to greater responsibility and complexity, strengthening their technical expertise, increasing their tacit understanding, and expanding their adaptability to confront novel situations, while programme leaders managed the consequences of error on the populations they served.

It is important to note that this centripetally spiralling process could not have functioned without assumptions about learners like those of Knowles. Had Langmuir and staff not believed in the officers' ability to draw on their own experience, to be self-directed, to learn from problems, etc., they could not have trusted the officers to learn from the situations in which they put them. Indeed, without such assumptions, we expect the foundational FETP would have a content-delivery curriculum.

Further research to aid population health and pandemic preparedness

Considering our findings and interpretations, we urge further exploration of FETP to support public health colleagues to prepare for the next pandemic and to inform scholarly debates on adult learning. Specifically, three areas merit attention: the role of culture, critical learning, and emerging adult learning theories.

First, we propose in-depth research on the implications of culture on learning in FETP. Learners in our case study were mostly White, male, medical doctors from and in the United States. Today, FETP has reached an array of cultural and linguistic contexts that require programme adaptations. Learning researchers tend to agree that culture plays a role in learning but disagree on the role it plays. For instance, Diouf and colleagues (2000) propose that adults across all cultures may learn best through hands-on practice with reflection and feedback but that what differs are the cultural norms and values influencing what, when, and from whom they learn. Hlela (2019) argues that there are similarities in African adult learning with situated and experiential learning, but that body, mind, and spirituality must be valued as legitimate sources of knowledge in that context. Bartolome warns that '[u]nless educational methods are situated in the students' cultural experiences, students will continue to show difficulty in mastering content area that is not only alien to their reality, but is often antagonistic towards their culture and lived experiences' (Bartolome, 1994, p. 191). Field epidemiologists go into communities with the responsibility of negotiating the meaning of health and disease, yet many of these communities have distinct epistemologies and/or ontologies. Research that identifies cultural differences and similarities across contexts could inform questions

of standardisation and adaptation in FETP and improve the way field epidemiologists interact with the communities they serve before the next pandemic arrives.

Second, we suggest an exploration of the role that critical learning should play in FETP. In our analysis, we did not find evidence of any critical approach to learning. Citing Torres (2015), Gouthro argues that adult education has become dominated by technocratic thinking and needs a critical social theory to enable 'adult educators to think deeply about global crises such as the current pandemic' (2022, p. 107). Gouthro proposes that a critical social theory could help in understanding that power permeates all learning contexts. Others have argued the need for such approaches in public health. For instance, Laverack (2019) outlines the link between public health and social justice through World Health Organization meetings and declarations and argues that public health practitioners must be aware of the conventional top-down approach and instead facilitate empowerment-based bottom-up approaches. Halman et al. (2017) state that training in the health field that focuses only on attitudes and behaviours can perpetuate existing problems while critical consciousness and critical learning can foster compassionate, humanistic, and socially conscious professionals. One promising approach is outlined in O'Hara's (2003) reframing of Rogers' work as transformative education, suggesting person-centred groups can transform group consciousness with individual consciousness, resulting in something larger than individual change while also improving individuals more than individual-focused approaches. In the same issue, Mayo (2003) presents case studies of transformative education within a hierarchical system, which could inform approaches in government programmes like FETP that may be resistant to critical or transformative approaches. Therefore, to guide FETP designers and implementers and advocate to governments hosting FETP, we need research into the appropriate use of critical learning in field epidemiology.

We believe three groups of theories – feminist, embodied, and post-human – are especially salient for preparing field epidemiologists in FETP. Each of these approaches employs a critical, holistic orientation that moves the focus from the individual to the structural, social, spiritual, or historical contexts shaping learning and what counts as knowledge.

Feminist pedagogies provide a guide to making visible the dynamics of power through their focus on the processes that lead to marginalisation, silencing, and hierarchies of knowledge. Public health practitioners constantly work with marginalised communities, for they tend to bear more of a population's burden of disease and have fewer resources to address it. Feminist pedagogies enable a learning group to interrogate the assumptions of and the 'taken-for-granted' privilege of dominant worldviews that have led to the oppression of women. In doing so, they foreground how oppressive systems and structures persist for women and other marginalised groups. Furthermore, as feminist pedagogy validates and encourages the sharing of lived experience, it provides 'connections between individual, lived experience (personal troubles) and social, cultural, political, and economic factors (public issues) [and] requires the development of what Mills and Gitlin (2000 allude to as the 'sociological imagination' (Gouthro, 2019, p. 67). Hirshfield (2022, p. 64) provides a useful application of this concept in medical education, arguing that it can facilitate 'trainees to integrate the epistemologically diverse forms of knowledge they are exposed to, to break down the silos that these forms of knowledge are taught within and to make sense of conflicting or competing frameworks'.

Similarly, adult learning theories that acknowledge the embodied nature of learning and the role of emotions in learning present an opportunity for FETP educators to help learners connect the objective and subjective dimensions of epidemic investigations. Working in a hospital or community in the grips of an epidemic, where injury, illness, or death are pervasive, obviously affects the senses and triggers emotions. Rather than viewing feelings and emotions as aspects to be suppressed or held aside to encourage learning, the overlapping space between emotion and cognition, 'emotional thought', as Immordino-Yang (2016, p. 208) has argued, is key to the learning process has demonstrated how utilising one's inner experiences and considering how these link to bigger ideas in the world can support deeper adult learning.

Finally, as Hodge and colleagues note (Hodge et al., 2022, p. 402), a 'decisive shift away from viewing learning as an essentially human concern is brought by post-human theories'. These theories suggest that ontologically centring humans distorts our understanding of the world and the world's processes, including learning. Epidemiology, which traditionally focused on human health, has recently embraced the concept of One Health: 'an integrated, unifying approach that aims to sustainably balance and optimise the health of people, animals and ecosystems' (World Health Organization, 2021). Whilst the first international forum on One Health occurred in 2012, the pandemic has brought its relevance into sharp focus. Key to One Health is the idea that humans must be decentred. Fenwick and Edwards (2010, p. ix) suggest actor-network theory as one that 'can open useful insights about the dynamics and objects of education'. They caution against calling it a theory and describe it 'as a virtual "cloud", continually moving, shrinking and stretching, dissolving in any attempt to grasp it firmly'. Humans, along with all other things – animals, trees, books, case studies, communities, ideas – become actors because of their networks and are part of the networks that engender other actors, and as actors, they enact forces on networks. This perspective obviously resonates with a holistic, integrated perception of health and disease. Its potential contribution to learning justifies its exploration.

Conclusion

The foundational FETP employed a constructivist humanist-situated approach to learning. The programme leveraged elements that align with Knowles's andragogical principles, Kolb's experiential learning cycle, and Lave's and Wenger's legitimate peripheral participation in communities of practice to build field epidemiologists while managing the risk to the populations the programme served. Such combination of principles, processes, and practices likely contributed to the longevity and spread of FETP across the globe and holds lessons for other population health programmes.

To conclude, we wish to call on the adult learning community to reach out to FETPs and support their leaders to further understand learning and collaborate with them to prepare learners to impact population health and prepare for future pandemics. Though FETP has developed thousands of field epidemiologists and public health leaders, scant information about how those programmes have adapted to local cultures, contexts, and needs is available. Adult learning as a discipline has a history of facilitating other fields to understand learning so that they can do it better. Today more than ever we need public health experts who are technically sound, critically aware, and multiculturally adaptable. COVID-19 challenged our patient-centred health paradigm, which struggled as healthcare systems became overwhelmed. As global temperatures continue to rise, the frequency of pandemics and humanitarian crises will also increase. The role of culture in training, the incorporation of critical learning, and the insights from recent adult learning theories are important opportunities for the adult learning and public health fields to collaborate in truly interdisciplinary endeavours.

Notes

1. Grouped under 'FETP', the programme names vary, e.g. FETP-Japan, Australia's Master of Applied Epidemiology, the European Programme for Intervention Epidemiology Training, the U.S. Epidemic Intelligence Service.
2. CDC was originally (1949) called the Communicable Diseases Center. It has changed names twice, and today is called the Centers for Disease Control and Prevention while retaining the acronym CDC.
3. 'Epidemic' refers to a health event, e.g. illness, occurring more than what is normally expected. 'Outbreak' refers to a localised epidemic, e.g. in a village or institution. Often the terms are used interchangeably. Here we have opted for 'Epidemic' unless quoting someone. For more see, Porta, M. (2014). *A dictionary of epidemiology* (Sixth ed.). Oxford University Press.
4. We note that because the descriptions focused on explicit learning activities, we have less information on the moments of learning that likely occurred in day-to-day interactions among peers and with supervisors.

5. Though we lack the data specific to the period under study, Thacker et al. (1990) report 3 percent of EIS Officers prior to 1980 represented minority groups and that the 1979 class had 8 women (15%).
6. Langmuir and Etheridge describe the 1951 course as 6 weeks, but Schaffner and LaForce (class of 1966) call it a 'month-long introductory course' (p. S17). We suspect that initial cohorts completed a six-week course, and then Langmuir reduced it to a month.
7. For colourful layperson accounts of such investigations, see Roueché's *New Yorker* articles "In the Bughouse (1965), 'A Man Named Hoffman' (1965), and 'Insufficient Evidence' (1970) *inter alia*.
8. For examples, see Mason and McLean (1962) or Wright (1968).
9. The other two being self-directed learning and transformative learning.

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Chapter 4 A METHODOLOGY FOR INVESTIGATING LEARNING IN FETP

After all, what troubles me is that I think there is still a little gap in between what we have learned from FETP and the application to the real world. . .[I]t is impossible for you to immediately expect the trainee to find a way to go to the scene to do some investigation after the class is finished.

—second-year FETP trainee, Taiwan

The previous chapter's case study had elucidated and placed the foundations of FETP learning in constructivist, humanist-situated learning. It identified alignment with established learning theories, identified important elements of the training programme, and suggested how FETP might have been able to endure and spread. Nevertheless, knowledge gaps persisted, for although I had identified the approach, nuances remained to be revealed, such as those for trainees' learning and trainers' training strategies, especially within contemporary FETPs. I thus hoped to bridge these gaps with a study of contemporary FETPs, and to do so, I needed collaborators.

My conviction for participatory action research meant that to explore learning in FETP I needed to collaborate with the people for whom the research would matter most. Wadsworth (1998) describes participatory action research as research involving all relevant parties to collaboratively examine actions to improve them by critically reflecting on the context that makes sense of them. Wadsworth distinguishes action researchers as those researchers who have come to understand the practical and ethical implications of

— raising certain questions and not others
— involving certain people in the process and not others
— observing certain phenomena and not others
— making certain sense of the inquiry and not others, and
— deciding to take certain action because of the inquiry and not others.

A key element of Wadsworth's approach to research is the involvement of a 'critical reference group' (CRG), i.e., "the researched for (in the sense of having the problem the research is to resolve)" (p. 6).

> The major challenge for all participatory action researchers (and indeed all researchers) is to design a process which can result in maximum creativity and imagination. Some of the most spectacular ideas have come about because researchers (or self-researchers) were able to draw on unusual sources for ideas, and then submit them to their critical reference group to see if they 'resonated'. If such creative and imaginative efforts have been well-driven by a critical reference group perspective and well-grounded in an understanding of the critical reference group and their context or environment (including the effects of others and of 'structural' matters or opportunities impinging), then they stand a much better chance of 'getting it right' and ideas 'taking off' (p. 5).

It was clear to me that the 'researched for' were the ones designing and leading FETPs—the trainers, advisors, mentors, faculty, and supervisors. To form a CRG of these practitioners, I drew on professional networks, reasoning that trust and relationships were essential: I would not have the time to build relationships with unfamiliar practitioners. Thus, I reached out to seven FETPs with whom I or my supervisors had worked and invited their lead trainers to collaborate on a study of FETP learning. Six accepted, representing Australia's Master of Applied Epidemiology, Fiji National University's Master of Applied Epidemiology, Japan's FETP, Mongolia's FETP, Papua New Guinea's FETP, and Taiwan's FETP. Unfortunately, two members left their professional positions within a year of forming the group, and their organizations did not replace them quickly enough to continue the work. I preferred to stay true to participatory principles, and I thus dropped their two programs from the study. So, the group comprised Dr Emma Field (Australia MAE), Dr Tomoe Shimada (FETP Japan), Munkhzul Battsend (Mongolia FETP), and Dr Angela Song-En Huang (Taiwan FETP).

In monthly discussions, we explored perspectives on learning and discussed their programs' research needs. They valued research that sought to identify what skills

trainees needed for the profession, how to communicate expected learning outcomes to stakeholders, how to stay relevant in the evolving landscape, and how to evidence trainee learning beyond questionnaires and evaluations. They also hoped to learn about international training standards, innovative training approaches, how each trainer in the group trained, and how alumni could be involved. Overall, they hoped the research would lead to better understanding of how to design or redesign FETPs. Sharing my comparisons between Langmuir's program and learning theories (as I developed the work presented in the previous chapter) sensitized the group to theoretical frameworks and the language of learning, enriching our discussions.

We agreed on initial research objectives. They were (1) to explain how programs train and trainees learn and (2) to identify what obstructs effective training. In discussions over a potential study, the group raised questions about how the study would account for diversity across programs, specifically with respect to quantitative research measures and the influence of context on learning. They also worried that findings might drive unnecessary standardization of programs. These discussions, hopes, and concerns informed the development of a study protocol. In this way, the members became more than a CRG: they became coresearchers of the study.

Our protocol underwent full ethics review at the ANU because it involved overseas participants. I received ANU ethics approval on 14 November 2022 (2021/771). Taiwan's FETP required expedited review of the ANU-approved proposal, which I obtained. I submitted the protocol as a manuscript to *BMJ Open* in July 2023. The journal published the protocol in February 2024. This chapter presents the published manuscript. It describes the methodology for what came to be the main study of this thesis.

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BMJ Open

How do field epidemiologists learn? A protocol for a qualitative inquiry into learning in field epidemiology training programmes

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ABSTRACT

Introduction COVID-19 underscored the importance of field epidemiology training programmes (FETPs) as countries struggled with overwhelming demands. Experts are calling for more field epidemiologists with better training. Since 1951, FETPs have been building public health capacities across the globe, yet explorations of learning in these programmes are lacking. This qualitative study will (1) describe approaches to training field epidemiologists in FETP; (2) describe strategies for learning field epidemiology among FETP trainees and (3) explain the principles and practices aligning training approaches with learning strategies in FETP.

Methods and analysis The research design, implementation and interpretation are collaborative efforts with FETP trainers. Data collection will include interviews with FETP trainers and trainees and participant observations of FETP training and learning events in four FETP in the Western Pacific Region. Data analysis will occur in three phases: (1) we will use the constant comparison method of Charmaz's grounded theory during open coding to identify and prioritise categories and properties in the data; (2) during focused coding, we will use constant comparison and Polkinghorne's analysis of narratives, comparing stories of prioritised categories, to fill out properties of those categories and (3) we will use Polkinghorne's narrative analysis to construct narratives that reflect domains of interest, identifying correspondence among Carr and Kemmis's practices, understandings and situations to explain principles and processes of learning in FETP.

Ethics and dissemination We have obtained the required ethics approvals to conduct this research at The Australian National University (2021/771) and Taiwan's Ministry of Health and Welfare (112206). Data will not be available publicly, but anonymised findings will be shared with FETP for collaborative interpretation. Ultimately, findings and interpretations will appear in peer-reviewed journals and conferences.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ This study will be codesigned, codeveloped and cointerpreted with practitioners to generate relevant, useful and informative findings for field epidemiology training programmes, practitioners and learners.
⇒ Use of multiple data collection methods and theoretical frameworks will improve the credibility of the findings.
⇒ Engagement of participants and programmes throughout the process to check interpretations and facilitate dialogue on findings will strengthen the trustworthiness of the findings.
⇒ The methodology aims to explore experiences in depth, and resources restrict the number of programmes and participants that may enrol. So, there will be limits to the generalisability of the findings beyond the included programmes.
⇒ As grounded theory aims for hypothesis generation not hypothesis testing, the findings will be limited to explanations of training and learning and thus not interpretable as statements of the effectiveness of training approaches or programmes.

INTRODUCTION

COVID-19 highlighted the importance of field epidemiology training programmes (FETPs).[1–4] Nevertheless, many countries struggled to cope with the demands of the pandemic. These struggles have been linked to insufficient numbers of, inadequate training for and low government regard for field epidemiologists.[5]

FETPs 'provide critically needed public health and global health security services through a mentored, learn-by-doing approach that emphasises fieldwork and improves the effectiveness of the workforce and the systems required to provide those services'.[6] Training includes 25% classroom and 75% field experiences (figure 1). Core topics include outbreak investigation, public health surveillance, epidemiological methods, data management and analysis, and public health communication.[6 7]

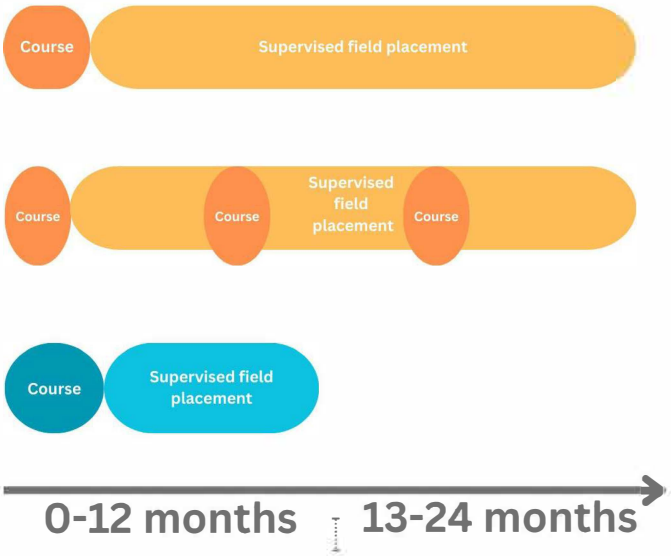

Figure 1 Example FETP designs. (Top) A 2-year 'Advanced' programme with intensive introductory course such as the programmes in Japan and Taiwan; (middle) a 2-year 'Advanced' programme with module-based instruction such as Australia's programme; (bottom) a 1-year 'Intermediate' programme with intensive introductory course such as the programme in Mongolia. FETP, field epidemiology training programmes.

FETPs have been building capacity for over 70 years. In 1951, Alexander D. Langmuir created the Epidemic Intelligence Service (EIS), aiming to develop epidemic expertise by turning medical clinicians into field-savvy epidemiologists, transforming their focus from the individual patient to the population.[8 9] The first EIS class had 22 white male physicians and 1 sanitary engineer.[10] In the 1970s and 1980s, countries began to copy the EIS model.[11 12] Today, 98 programmes build public health workforce capacities in more than 200 countries and territories.[13]

Despite FETP's importance, longevity and spread, explanations of its learning processes are lacking. One review of the FETP literature notes an impressive list of outputs with few discussing how trainees apply new knowledge, skills or attitudes.[14] Recent work continues to document FETP outputs and contributions to public health.[1 3 4] Although some publications use Kirkpatrick's[15] training evaluation levels to assess application of learning, they do not explore the learning process.[16 17] For instance, an evaluation of multiple FETP focused on Kirkpatrick's levels 3 (behaviour) and 4 (results) found that most graduates engaged in field epidemiology activities and perceived their FETP experience to have helped them perform these roles. It did not assess programme competencies or skills of the graduates nor explicate the learning process.[18]

In contrast, articles describing learning processes in medicine and nursing abound.[19–24] To take one example, Ohta *et al* used grounded theory to reveal learning processes in Japanese medical students' transitions to rural community hospitals.[25] They found that integration of cognitive apprenticeship[26] and legitimate peripheral participation in communities of practice[27] with learners' regular reflection on performance facilitated their learning family medicine. For a second example in an outbreak-like setting, Taber *et al* illuminate learning processes of paramedics and firefighters in Canada.[28] Their findings align with Lave and Wenger's[27] learning characterisations. Training sessions are only a beginning, while understanding comes in practice where they learn from one another and adapt to fit their realities into the policies, protocols and structures to respond to emergencies. When they face novel situations, paramedics and firefighters employ active, creative and immediate learning that the authors note merit further research. No such studies appear for learning in 'field epidemiology' or 'epidemiology'.

Considering the importance, diverse contexts in which it operates, and perceived success at training public health professionals, FETP is fertile ground for learning research. We propose a qualitative exploration of learning in FETP with the following objectives:

1. Describe approaches to training field epidemiologists in FETPs.
2. Describe strategies for learning field epidemiology among trainees in FETPs.
3. Explain the principles and practices that align training approaches with strategies for learning in FETPs.

We anticipate that understanding the FETP learning principles and practices will inform how to upscale, adapt to context, balance standardisation and adaptation, and measure learning and inform how training approaches should evolve with the theories informing adult learning today. Also, we hope that this protocol informs future research into FETP learning across diverse geographical, wealth and programme contexts.

METHODS AND ANALYSIS

Study design

This qualitative, exploratory research will be designed, implemented and interpreted with end-users of the findings. The germ for research into FETP learning came with the principal investigator (PI), but the design, including the questions and analytical approach, and the interpretation of data will be collaborative efforts with FETP trainers of participating programmes who meet virtually each month, following the Critical Reference Group approach of Wadsworth. Involving trainers in this collaborative approach is expected to improve the study's relevance for the people who share the problem; focus research questions; enhance study relevance for those whose jobs entail doing something about it; increase the research design's effectiveness; improve the meaningfulness of the information gathered; strengthen power and accuracy of the theory that the research generates; improve relevance, creativity and effectiveness of the actions that are based on the study; and strengthen commitments for following up on actions and researching them further.[29]

We will use two methods for collecting data: participant observations of FETP training and learning events and in-depth unstructured interviews with FETP trainers and trainees. We will analyse the data in three phases, employing the constant comparison method of grounded theory[30 31] during the first two phases to generate categories and properties inductively from the data. We will employ analysis of narratives and narrative analysis[32] during the second two phases to construct narratives that reflect the domains of interest. In the third phase, we will integrate the narratives to identify correspondence and non-correspondence among practices, understandings and situations[33] to explain the principles and processes of learning in FETP.

Reflexivity statement

The PI and coresearchers of this study are public health professionals who have worked in governments, clinics, hospitals, universities, WHO, US Centers for Disease Control and Prevention and FETP. We were born, raised and educated in multiple countries, mostly in the Western Pacific Region. Most of us are alumni of FETP. Our ages range from 30s to 50s, and most of us identify as female. We are interested in learning processes and how to facilitate them with training approaches to improve public health and health security, and we are interested in how differences in cultural, educational and professional backgrounds affect training and learning. Our positionality influences our perspective and relationships to the research and participants. Thus, we seek to codesign and cointerpret the study.

Theoretical framework

We will situate this research in the constructivist paradigm with grounded theory, narrative inquiry and critical action research. Grounded theory is a social research method that aims to generate explanatory theory inductively from analysis of social research data.[30] We will draw on the constructivist grounded theory methodology of Charmaz, who argues that while quantitative research aims for statistical inferences, grounded theory aims to fit theories emerging from the data with the data. It supplies evidence for emerging hypotheses that quantitative research could pursue.[31]

Narrative inquiry focuses on narratives, which display human existence situated in action.[32] It examines human lives and lived experiences as sources of legitimate knowledge and understanding[34] and reveals our social nature, social structures and how humans make sense of the world.[35] Here, we will employ Polkinghorne's analysis of narratives and narrative analysis.[32]

As public health practitioners, we believe research should inform action. We will draw on the seminal work of Carr and Kemmis and of Wadsworth.[29 33] Critical action research aims for change: explanations and understandings are not ends but steps in the process. Action research for learning relates practices, understandings and situations to one another to discover correspondence and non-correspondence.[33]

Setting and participants

Given the research resources available, we estimate that we can conduct 40 interviews and assume that fewer than 8 interviews per programme (2 trainers and 6 trainees of 3 per cohort) will not likely provide meaningful data. Thus, we aim to invite five programmes to participate. Although including multiple geographical regions could provide useful insight, it will introduce more variability that will complicate interpretations. Working across geographical regions will also increase the cost of the research. Additionally, we consider that Basic and Frontline programmes differ substantially from Intermediate and Advanced because of the training content, duration and target participants[36 37], and their inclusion will complicate interpretation. Thus, expecting that some invited programmes will not participate, the PI has invited seven Intermediate and Advanced programmes from the WHO's Western Pacific Region. These seven programmes differ in duration, cohort size, years in operation, host institution, recruitment strategy, entry requirements, accreditation and programme design, as well as national language and health systems. They have similar aims for developing field epidemiologists through field-based service to contribute to national health security.

To participate, programme directors will have to agree for trainers and trainees to enrol in the study and for one trainer to serve as a coresearcher committing to monthly virtual calls to discuss research aims, questions, direction and interpretation of data. Among the invited programmes, six have agreed to take part. At the time of writing, four will participate: Australia's Master of Applied Epidemiology, Japan's FETP, Mongolia's FETP, and Taiwan's FETP. The other two programmes expressed interest in joining the study but withdrew because of administrative issues.

Participants will include trainees and trainers in the participating programmes. For this research, a 'trainee' will be anyone enrolled in a participating programme during the study period. A 'trainer' for this research will be anyone recognised by the programme as one who designs or delivers an activity intended to change the knowledge, skills, awareness, attitudes or behaviours of trainees. In FETP, many people are involved in such activities: some are employed staff of the programme with a responsibility to supervise or train; some are public health professionals not employed by the programme who provide short courses, advise on projects, support field work, etc; and others lie between these extremes, such as professionals not employed by a programme who supervise field deployments and lecture regularly. We will ask coresearchers to identify those most involved in training, mentoring or supervising current trainees as 'core trainers'. We will not exclude participants based on language.

We will conduct participant observations during training and learning events in participating programmes. Training and learning events will be those activities that are organised to intentionally change knowledge, skills, awareness, attitudes or behaviours of field epidemiology trainees. We will use those events organised as a routine part of the programme instead of requesting programmes to organise events for observation. Examples include courses, workshops, case studies, mentor and supervisor meetings, and group projects. Because of the nature of participant observation, all trainers and trainees present during the observation will be participants, including trainers who may not be defined as 'core trainers', such as guest lecturers.

Recruitment

Our sampling strategy will follow grounded theory approaches outlined by Glaser and Strauss and Charmaz.[31 38] Glaser and Strauss promote 'theoretical sampling', a procedure with concurrent collection, coding and analysis of data so that analyses can suggest further data to collect. They note that the researcher should select individuals and groups based on their potential to generate properties of categories and help relate categories to one another. For Charmaz, theoretical sampling means collecting more data about specific actions, experiences, events and issues to illuminate variation within a category or process. Charmaz distinguishes initial sampling from theoretical sampling. For initial sampling, Charmaz advises setting criteria and starting with relevant material for the study. Theoretical sampling begins when preliminary categories have arisen and helps to check, qualify and elaborate the categories and the relations among them.[31]

Our initial sampling will focus on participant observations and in-depth interviews. For participant observations, we will select one training and learning event per programme in collaboration with each programme's coresearcher and programme director. As the goal of the participant observation is to provide an initial view into the nature of the training-learning environment, the criterion for selecting the event is that it is routine for that programme. To maximise resources, we will aim for events occurring over at least five consecutive days. The programme director and coresearcher will distribute participant information sheets that are approved by the ethics review committee(s) and explain the participant observation to all individuals who may be present during the event, discuss risks and benefits, answer questions, and identify individuals who hesitate to participate. For these individuals, the director and coresearcher will ascertain if the hesitancy represents a refusal for the event to be observed or a refusal for data to be collected on that individual. In the case of the former, the participant observation will not proceed. For the later, the participant observation will proceed with no data being collected on that individual. Directors will then sign an assent form for the observation to proceed, which covers all participants at the event. All participants at the event will be advised that they may raise ethical concerns, hesitations, questions and requests to halt the observation at any time by approaching the coresearcher, director or PI.

For interviews, we will enrol a pool of trainers and trainees from which we can conduct initial and theoretical sampling. For trainees, we will use diverse strategies because the cohort size and cultures of participation in research varies across programmes. For larger programmes (>15 trainees) with high expected participation rates (>50% as judged by the coresearchers and PI), we will randomly select ten trainees to approach. For larger programmes with low expected participation rates (<50%), as well as smaller programmes (≤15 trainees) regardless of participation rates, we will approach all trainees. We will seek to enrol 'core trainers', and as the number of them is smaller than ten in each programme we will approach all of them.

Coresearchers from the respective programmes will send an email invitation to all selected individuals using the national language and include as attachments the participant information sheet and informed consent form approved by the ethics review committee(s). The invitation and information sheet will clarify that participation is voluntary and that no one from the respective programmes knows if they have chosen to participate. The invitation will include a link to an enrolment website where the individual can enrol or decline to participate. For those choosing to enrol, the website will ask the participant to confirm having read the informed consent document and confirm agreement to participate with an electronic signature. When participants confirm agreement to participate, the website will request demographic information to facilitate initial sampling: year of birth, gender, programme, language, role (trainer or trainee) and for trainers their number of years training. The registered responses will be available to the PI, not to the coresearchers. Because coresearchers will not know the responses of the invited individuals, they will send two follow-up emails at 1-week intervals to all invited individuals in their programmes. The follow-up email will say that the coresearcher does not know who has decided to enrol and thus is reminding all who have been invited. The pool of potential participants will comprise all those who indicate through the website that they agree to participate.

For initial sampling, we will aim to enrol from the pool three trainers and three trainees per cohort (eg, six for Advanced programmes) for each programme. We believe three is a minimum initial sample to guide theoretical sampling. If two participants have opposing perspectives, a third perspective would suggest sampling towards one or the other. We will also aim to include one male, one female, one 35 or older, and one younger than 35 for both trainers and trainees from each programme. Trained bilingual interviewers not associated with the programmes will contact these individuals by email to arrange the first interviews. Interviews will begin with a review of informed

consent, confirmation to video or audio record and clarification that the participant can skip any question, halt the interview and decide at any point until the data are prepared for publication to remove the interview from the study.

As we analyse data from the initial sample, categories and properties emerging from the data will suggest further sampling from the same participants (ie, follow-up interviews) or from others who agreed to participate until we reach theoretical saturation. Charmaz describes theoretical saturation as the saturation of theoretical categories with data, when relationships among categories and variation within and between them have been defined, checked and explained.[31] If necessary, we will invite trainers or trainees beyond the initial pool.

Data collection

Data collection will employ two methods: participant observation and in-depth interviews. DeWalt and DeWalt describe participant observation as a data collection method that occurs in a naturalistic setting involving observation and/or participation in the activities of the people under study. As a method, it uses explicit recording and analysing of information gathered from participating and from observing. This method can provide context for sampling, interviewing and construction of interview guides and is rarely the only technique for a study.[39] Patton summarises the advantages of the method: facilitates better understanding and capturing of context within which interactions occur; allows the researcher to be open, discovery-oriented and inductive and provides opportunities to see what escapes the awareness of the people in the setting and to learn about things that individuals may not disclose in interviews.[35]

For participant observations, the coresearcher of the respective programme will introduce the PI at the beginning of the selected event, clarify procedures and answer questions. The coresearcher will note that as an experienced field epidemiologist and trainer, the PI is available to support the event as much as possible. For example, trainers and trainees may ask the PI questions and solicit help where relevant. This approach aligns with the participant aspect of participant observation and reduces the discomfort of being observed by an outsider. The PI will participate in and observe participants' interactions, discussions and behaviours, as well as the setting. The PI will engage in casual conversations with participants letting them lead conversations to avoid tending towards interviews. Where the PI does not speak the language, a bilingual member of the programme will interpret. The PI will record notes and convert them into field notes at the conclusion of each day. Words and behaviours will not be attributed to individual participants but to 'a trainee' or 'a trainer.' Field notes with the researcher's ruminations on them will comprise the data of participant observations.

We will use in-depth interviews because, as Patton observes, they allow researchers to enter the perspective of research participants, understand what we have observed, and gather feelings, thoughts, intentions and meaning.[35] Though we do not believe the topic is sensitive, participants in many FETP are government employees. They may hesitate to disclose opinions in participant observations or focus groups but feel comfortable doing so in confidential interviews.

We will conduct in-depth, unstructured interviews with trainees and trainers to explore experiences with training and learning in FETP. Interviews will last 1–2 hours and be conducted online. Participants can choose the time and place for the interviews according to their comfort and the rules of their workplace. For trainees, we will explore their experiences with training and learning. Training experiences have been defined above. Learning experiences will be those in which the trainee sought or perceived a change in knowledge, skills, attitudes, awareness or behaviours for field epidemiology. Topics on the trainee initial interview guide include motivation to learn field epidemiology; daily life/world in the programme; learning or conducting outbreak investigations, surveillance, public health communication and epidemiological methods; participating in courses or classes; mentoring and supervising; most difficult/important thing to learn in FETP; process for getting through struggles or challenges; perceived changes in self throughout FETP; how gender, age, culture or background made the experience easier/more difficult and how FETP fits with the trainee's vision. For trainers, we will explore their experiences with training in these programmes using similar topics on the trainer initial interview guide but relevant to training, for example, motivation to train field epidemiologists.

We will train bilingual qualitative interviewers to conduct interviews in English, Japanese, Mongolian or Mandarin Chinese, transcribe them and translate them into English. Following the work of Polkinghorne[40] and McCance *et al*,[41] we will train interviewers to use the guide to elicit trainees' narratives of their experiences, emphasising depth over breadth; to develop rapport with casual conversation; and to use broad questions based on the topics. For example, tell me about the last outbreak investigation you participated in. We will train them to avoid interrupting responses and to probe to facilitate relating stories.

Interviewers will transcribe the interviews. Interviewees will then have 30 days to review the transcripts to add comments, indicate where the meaning has been misunderstood, and request removal or alteration of sections that they feel are difficult to deidentify. This step will ensure participants do not perceive unnecessary risk to their programme nor their career. Interviewers will then translate the interviews and include perceived changes in verbal and non-verbal communication, such as laughter and speeding up speech, to aid analyses.

We will digitise all data and upload them to secure password-protected folders. Once the PI has reviewed

interview transcripts and the interviewer has clarified doubts and questions, we will destroy the original recordings.

Data analysis

We will analyse the interview and participant observation data in three phases. For phase 1, the PI will begin with open coding of data using the line-by-line comparison method[31] with NVivo V.12 Pro.[42] The PI will present the coding book and deidentified excerpts of the data to the co-researchers, who will then discuss interpretations as compared with those of the PI to focus analyses and inform phase 2: focused coding. In focused coding, we will use constant comparison for larger sections of data and introduce analysis of narratives.[32] Following Charmaz, we will retain multiple major codes while remaining open to modifying focused codes and moving between open and focused coding because the process is not linear.[31] We will employ Polkinghorne's analysis of narratives, identifying stories about focused codes and using paradigmatic analysis to generate themes or classifications (categories and properties in grounded theory) across the stories.[32] The unit of analysis is thus the story in phase 2, which Polkinghorne defines as sustained and emplotted accounts having a beginning, middle and end, plots being the conceptual schemes that display contextual meaning and draw events and actions together into an organised whole. During the third phase, we will employ Polkinghorne's narrative analysis.[32] We will use the stories in the data and elements from data not in storied form to develop narratives that reflect the domains of interest to the researchers. We will integrate these narratives to reveal correspondence/non-correspondence of practices, understandings and situations[33] for training and learning in FETP. We will arrange to dialogue with participating programmes' trainers and trainees including those not involved in interviews and with the wider FETP community to interpret correspondence and non-correspondence and explain training and learning.

Trustworthiness and credibility

We will implement the following procedures suggested by Patton to improve trustworthiness and credibility: (1) conduct in-depth qualitative field work guided by established methods and theoretical frameworks, integrating and triangulating diverse sources of qualitative data; (2) use constant comparative analyses; (3) involve multiple investigators to triangulate analyses and (4) seek alternative explanations, divergent patterns, rival explanations and negative cases in the data to avoid biases shaping the findings.[35] Also, following Wadsworth, the codesign, coimplementation and cointerpretation of the research with practitioners in FETP should improve the study's relevance, focus research questions, increase design effectiveness, improve meaningfulness of the data, strengthen power and accuracy of the generated theory, and improve the relevance and effectiveness of recommendations.[29]

ETHICS AND DISSEMINATION

We have obtained approval from The Australian National University Human Research Ethics Committee to conduct this research (2021/771), unconditional approval from ANU Institutional Research, which oversees research on ANU students, and approval from the Institutional Review Board of Centers for Disease Control, Ministry of Health and Welfare, Taiwan (112206). No additional approvals are required.

We will publish findings in professional journals and conferences. A website with links to disseminated findings will be available to the public and to participants.

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Contributors MMG developed the study concept and approach collaboratively with all coauthors, drafted the manuscript and revised the manuscript. EF developed the study concept and approach collaboratively with all coauthors and revised the manuscript. AS-eH developed the study concept and approach collaboratively with all coauthors and reviewed the manuscript. TS developed the study concept and approach collaboratively with all coauthors and revised the manuscript. MB developed the study concept and approach collaboratively with all coauthors and reviewed the manuscript. TH developed the study concept and approach collaboratively with all coauthors and revised the manuscript. BP developed the study concept and approach collaboratively with all coauthors and revised the manuscript. MDK developed the study concept and approach collaboratively with all coauthors and revised the manuscript.

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Competing interests None declared.

Patient and public involvement As described in this manuscript, we have involved end-users as collaborative researchers in the design, implementation and interpretation of the research and will engage programme directors, trainers and trainees, including research participants, in the sharing and interpretation of findings.

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Chapter 5 The FETP learning process and its key facilitators

I don't know what I've learned. I don't know how to know [that I've learned]. My God! I should do more research or go to more outbreaks, or maybe I should have studied it more in [the course].

— first-year FETP trainee, Mongolia

With agreement from the coresearchers and approval of the ANU and Taiwan CDC ethics committees[2], I began collecting data in December 2022 and continued until March 2023, analysing concurrently. As I coded the data, I brought them to the coresearchers, and their interpretations and suggestions led to revisions of the coding scheme. For example, they wanted to know about training courses because their programmes invested heavily in them, which led to analysing training courses as a learning context distinct from field investigations and workplaces.

Findings developed through iterations of analysis, interpretation, and discussion. Those discussions occurred not only with these coresearchers but also with professionals in health security, education, and other FETPs at conferences and meetings (see **Table 5.1**). Resonance with these audiences reinforced the verisimilitude and trustworthiness of the findings, and their questions encouraged me to look again at data, findings, and interpretations. I have included some of these presentations in Appendix C. Presentations of Preliminary Findings.

Regarding the findings, I sought first to describe the learning process and its key facilitators. My decision to focus on those came from a meeting with the coresearchers in which one of them said, 'I want to know what motivates trainees and how to leverage

[2] As noted in the published manuscript, no other participating FETP required ethics review.

that'. After reflecting on her comment, I recognized that it was essential to first layout the overall process. Only then could I explore aspects of it in depth. So, I wrote up a manuscript that aimed to clearly describe the FETP learning process emerging from the data, as well as the key facilitators of learning environments, advisor stewardship, and trainee tenacity.

I submitted the manuscript in October 2024 to *BMC Medical Education*. Peer review again illuminated the importance of distinguishing this work from the evaluation literature and further explaining our participatory approach and integration of grounded theory and narrative analysis. The journal published the revised version in March 2025.

This chapter presents the published manuscript. In addition to describing the learning process, I point to misalignment (Carr & Kemmis, 1986) between investment in training courses and the scarce learning identified there. Again, Lave and Wenger's (Lave & Wenger, 1991; Wenger, 1998) work proved beneficial for explaining why learning was more robust in other learning environments beyond the course. I conclude by recommending enhancing learning environments, ensuring advisor accessibility, cultivating tenacity among trainees, and researching cultural contexts, advisor stewardship, and trainee tenacity.

Table 5.1. Activities in which I presented preliminary study findings.

Venue	Location; month year	Activity
The South Asia Field Epidemiology and Technology Network (SAFETYNET) Scientific Conference	Canberra, Aus; September 2023	Brown Bag Learning Session, "Learning by doing: Is there more to it?"
Internal meeting with FETP Japan	Tokyo, Japan; December 2023	Report-back presentation, "Learning Learning to Transform Training in FETP"
Global Health Security Conference	Sydney, Aus; June 2024	Peer-reviewed oral presentation, "Bringing the Field to the Classroom: How FETP in Asia-Pacific Leverage Situated Learning to Prepare the Health Security Workforce"
Australian and New Zealand Association of Health Profession Educators (ANZAHPE) Annual Conference 2024	Adelaide, Aus; July 2024	Peer-reviewed oral presentation, "Global standards, local wisdom: An exploration of learning among epidemic-investigator training programs"
XVIII World Congress of Comparative Education Societies	Ithaca, USA; August 2024	Peer-reviewed oral presentation, [1]"Global standards, local wisdom An exploration of learning among epidemic-investigator training programs"
Internal meeting of US CDC's FETP Branch	Virtual; August 2024	Invited presentation, "Is There More to FETP Than 'Learning by Doing'? And What Could the Answer Mean for How We Train?"
Internal meeting of the WHO Global Hub for Pandemic and Epidemic Intelligence	Virtual; September 2024	Invited presentation, "Is There More to FETP Than 'Learning by Doing'? And What Could the Answer Mean for How We Train?"
The 13th Asia-Pacific Action Alliance on Human Resources for Health (AAAHRH) Conference	Vientiane, Lao PDR; October 2024	Invited presentation, "Pathways to Resilience: Embedding and Empowering Field Epidemiology Capacities"

[1] Although this presentation and the previous had the same title, the information was presented differently to engage the distinct audiences.

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RESEARCH

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How does learning happen in field epidemiology training programmes? A qualitative study

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Abstract

Background Despite a 75-year history of building epidemiologic capacity and strengthening public health systems, the learning processes in field epidemiology training programmes (FETPs) remain unexamined.

Methods We codesigned a grounded theory and narrative inquiry qualitative study to fill this gap. The study aimed to understand the learning processes in four FETPs by describing training approaches for field epidemiologists, outlining learning strategies among trainees, and examining principles and practices that align training approaches and learning strategies. Data collection included participant observations and semi-structured interviews with FETP trainees and advisors within programmes in Australia, Japan, Mongolia, and Taiwan.

Results Analysis revealed that learning occurs as trainees engage in real-world public health contexts, interacting with their people, systems, data, and knowledge. Facilitators of the learning process were learning environments (projects, routine placement work, field investigations, and courses), advisor stewardship, and trainee tenacity.

Conclusions Our findings align with established and contemporary learning theories and suggest that all countries have the tools to build field epidemiology capacity and leadership. To refine these tools, governments, partners, and programme leaders should ensure access to learning environments, fortify advisor stewardship, and foster a culture of resilience among trainees. FETP is among the strongest levers to bolster the workforce for global health security before the next pandemic, and these findings reveal pathways toward better investments.

Keywords Field epidemiology training programmes, Epidemiologic capacity building, Public health training, Public health workforce development, Health security, Adult learning

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Background

Field epidemiologists play a critical role in public health. They investigate urgent problems 'to guide, as quickly as possible, the processes of selecting and implementing interventions to lesson or prevent illness or death' ([1], p. 3). These urgent problems include outbreaks [2], armed conflict [3], and disasters [4]. During the COVID-19 pandemic, field epidemiologists worked in surveillance, case investigations, response coordination, point of entry, and risk communication, detecting cases, assessing the risk and spread of SARS-CoV-2, and disseminating information [5].

For almost 75 years, the core training mechanism for field epidemiologists has been the field epidemiology training programme (FETP). These programmes employ service-based, hands-on training that emphasizes *learning by doing* to develop skilled field epidemiologists who detect, investigate, and control disease outbreaks; conduct surveillance and applied epidemiology studies; and measure intervention impacts [6]. Since the first programme in the USA in 1951, which aimed to turn clinicians into field-savvy epidemiologists [7], almost 100 FETPs have operated in more than 200 countries and territories [8]. The WHO Joint External Evaluation recognizes FETP as a key component of workforce development [9]. For more details about FETP, see [10–12].

Despite the critical role of FETPs in public health, systematic research into FETP learning processes is scarce. A few studies have examined supervision quality and impact [13, 14], and one explored alignment of the foundational programme with adult learning theories [15]. Most of the FETP literature comprises commentary (for example, [16–18]) or evaluation of programme outputs and outcomes. Al Nsour and colleagues reviewed the FETP evaluation literature and concluded 'substantial positive impact of FETPs on trainees and graduates' ([19], p. 10). The review identifies evaluation outcomes for skills and knowledge, involvement of trainees and graduates in field epidemiology activities, improvements in field epidemiology functions, and others. It identifies gaps including coverage of the programme, funding, mentoring, and enticement of veterinary and medical school graduates. Evaluations are essential to understanding and improving training programmes as they reveal *whether* trainees have learned, but they do not reveal *how* trainees have learned. A gap thus persists in the literature on *how* trainees learn, how contextual factors influence learning processes, and how emerging adult learning theories might inform training approaches.

To address these gaps in the literature, we sought to understand the learning processes in today's FETPs. Such understanding could inform strategies to scale training during emergencies, adapt an FETP to context, balance global standardization with local needs, measure learning, and align training with technological advances and modern adult learning theories. Specifically, we explored learning within four FETPs by 1) describing training approaches for field epidemiologists; 2) outlining learning strategies among trainees; and 3) examining principles and practices that align training approaches and learning strategies. In this paper, we describe the common learning processes across programmes.

Methods

This co-designed study situated in constructivist qualitative research explored learning processes in the FETPs of Australia, Japan, Mongolia, and Taiwan. Our design employed grounded theory and narrative inquiry because they align with our worldview and research aims. Grounded theory is a social research method that aims to generate explanatory theory inductively from analysis of social research data [20]. Charmaz [21] argues that while quantitative research aims for statistical inferences, grounded theory aims to fit theories emerging from the data with the data, supplying evidence for emerging hypotheses that quantitative research could then pursue. Narrative inquiry focuses on narratives as displays of human existence situated in action, examining lives and lived experiences as sources of knowledge and understanding [22] and revealing our social nature, social structures and sense-making [23]. Data collection included in-depth semi-structured interviews and participant observations, and analysis followed Charmaz's [24] grounded theory and Polkinghorne's [27] analysis of narratives and narrative analysis. For a comprehensive description of the wider study methodology, see [24].

The lead researcher (MMG) invited seven one- and two-year FETPs from the WHO Western Pacific Region to participate in this study. The programmes differed in duration, training cohort size, years in operation, host institution, recruitment strategies, national language, and health system. Minimizing further variability that might have complicated interpretation and maximising resources led to limiting invitations to one region. To participate, programme directors had to agree for a lead trainer to serve as a coresearcher. Six FETPs agreed to participate with two later dropping out for administrative reasons. Table 1 provides an overview of the four participating FETPs. The programmes varied in aims, duration, recruitment, cohort sizes, supervision and mentoring, and course structures. Australia's programme alone offered a master's degree and required a research thesis. Mongolia's programme had the shortest duration and was the only one to include a group project.

We codesigned the study with a lead trainer, facilitator, convenor, or supervisor from each participating FETP

Table 1 Key elements of the four FETPs (2022 – 2024) included in this study

Country	Taiwan	Australia	Japan	Mongolia
Duration	24 months	22 months	24 months	11 months
Trainees per cohort (n)	2 – 3	15 – 24	5 – 20	8 – 10
Aim	Develop capacities to manage outbreak investigations and contribute to the country's knowledge of epidemic risk, prevention, and control	Train public health leaders of the future, build highly skilled epidemiology workforce, strengthen capacity to protect Australia and [its] region	Develop human resources for early detection, assessment, and response of local, national, and international health crises	Develop capacities to conduct epidemiological research and apply it to outbreaks, thus building country's research and investigation capacities
Main training components	4-week intro course spread over 2 – 3 months[a] Research projects Outbreak investigations Second-year placement in Taiwan CDC regional centres	Three 2–3-week course blocks Field placements across country Four competency-based projects Thesis	4-week intro course Routine surveillance monitoring and risk assessment Two research projects Outbreak investigations	8-week ½-day intro course Two individual, one group research project Regular assessments Outbreak investigation
Mentoring and supervision	One staff assigned to each trainee	≥ 2 supervisors per trainee (≥ 1 field and ≥ 1 academic)	Staff assigned to trainees based on trainee task or topic	One volunteer mentor assigned to each trainee

[a] The programme typically uses a 4-week introductory course but adjusted to the spread-out model because of the COVID-19 pandemic

(authors EF, TS, ASH, and MB). We modelled the co-design on Wadsworth's Critical Reference Group [25]. During monthly virtual discussions, the lead researcher and lead trainers from participating FETPs discussed perspectives on learning and programmes' research needs, leading to our initial research objectives: to understand how programmes train, how trainees learn, and what prevents effective training. These discussions informed the study design.

The lead researcher (MMG) conducted participant observations [26] for five consecutive days each in Australia, Japan, and Mongolia. We did not conduct observations in Taiwan because of resource and scheduling constraints. The directors of the programmes discussed the participant observation protocol with all potential participants, clarifying that they could opt out. Directors addressed any concerns and signed informed consent for the programme to participate in the observations. During participant observations, the lead researcher observed and took field notes on advisors and trainees during classroom training sessions, project meetings, outbreak investigation planning, group project development, project presentations, and routine surveillance meetings. He also interacted with advisors and trainees through informal conversations between activities. For this study, we used the term 'advisor' for trainers, mentors, facilitators, and supervisors because each programme used different terms, and the same people often performed multiple roles. A field protocol for participant observations is available as a supplementary file.

For interviews, we enrolled a pool of trainees and advisors from each FETP. Because of programme sizes and research participation cultures, we invited all trainees from Japan, Mongolia, and Taiwan and a random sample of 10 trainees from Australia. We invited all core advisors—identified by coresearchers as those most involved in training, mentoring or supervising current trainees—to enrol. All enrolled participants provided demographic information and informed consent to participate as interviewees and have interviews video recorded. We then selected participants from the enrolled pool for interviews, aiming for diversity in age, gender, and educational background within each programme. Table 2 presents the interview recruitment numbers.

We trained three bilingual interviewers to conduct semi-structured interviews virtually in Mongolian, Mandarin, Japanese, or English. Interview guides are available in a supplementary file. Interviewers transcribed the interviews and provided the transcripts to the interviewees for concurrence before translating them into English. We conducted 47 interviews, 1–3 each with 19 trainees and 6 advisors. Table 3 details the participant characteristics.

The lead researcher began analysis with open and then focused coding following Charmaz [21], using NVivo 14. He read interview transcripts and participant observation field notes employing constant comparison [20, 21] to generate initial codes and coding trees and brought those with relevant data to the monthly meetings with co-researchers. They read transcript excerpts, provided interpretations, and discussed verisimilitude and usefulness of the coding, which informed adjustments to the coding scheme.

For focused coding, we integrated analysis of narratives [27] by identifying stories in the data and coding them according to the coding scheme while remaining open to emerging codes. We followed Polkinghorne's ([27], p. 12) definition of 'sustained emplotted accounts with a beginning, middle, and end.' Plots were conceptual schemes that provide contextual meaning and integrate events into an organized whole. Narratives ranged from complete stories with clear sequences of events and meanings to fragmented stories that required composition through probing questions or researcher synthesis. Again, the lead researcher brought coded data to the co-researchers for interpretation and discussion of verisimilitude and usefulness, further adapting the coding.

Next, the lead researcher employed narrative analysis [27], integrating narratives by programme to construct one case narrative for each programme. By 'case narrative' we mean each FETP's story of trainees coming to and going through the programme, synthesising the observed or recounted experiences in the data into a common account. Doing this reduced the likelihood that

Table 2 Recruitment of trainees and advisors for interviews from participating FETP

	Trainees				Advisors			
Program	**N**	**Approached**	**Agreed**	**Interviewed**	**N**	**Approached**	**Agreed**	**Interviewed**
Australia	34	10	10	6	8	5	0	0
Japan	28	28	11	6	6	2	2	2
Mongolia	15	7	4	3	5	5	3	3
Taiwan	4	4	4	4	3	2	1	1
Total	**81**	**49**	**29**	**19**	**22**	**14**	**6**	**6**

Table 3 Characteristics of the interviewed FETP trainees and advisors

Characteristics		Trainees *n* (%)	Advisors *n* (%)
Education (highest degree)	Medical or Veterinary	9(47)	3(50)
	Bachelor	7(37)	2(33)
	Master or PhD	3(16)	1(17)
Gender (self-identified)	Female	12(63)	3(50)
	Male	7(37)	3(50)
Age (at time of study enrolment)	25 to < 30	2(11)	0(0)
	30 to < 35	6(32)	0(0)
	35 to < 40	5(26)	2(33)
	40 to < 45	4(21)	2(33)
	45 to < 50	2(11)	2(33)
Year (at first interview)[a]	1st	12(63)	NA
	2nd	7(37)	NA
	< 2 years	NA	1(17)
	2 to < 10 years	NA	5(83)
Profession prior to FETP	Public health	11(58)	3(50)
	Medicine	7(37)	3(50)
	Veterinary	1(5)	0(0)
Total		19(100)	6(100)

[a] We interviewed three trainees in their first and then second years

any one participant's experience might overly influence the findings. After constructing the case narratives, we compared them with the remaining (non-story) interview and participant observation data to ensure consistency. For contrasting data, we either incorporated them into the case narrative or adjusted the language of the case narrative to reflect the diversity. The lead researcher met with each co-researcher to assess the verisimilitude of the programme's case narrative. We then compared the four case narratives, returning to grounded theory's constant comparison, to identify common learning processes and contextual factors influencing them.

Results

Comparison of the four case narratives revealed a common learning process and facilitators of that learning process. Here, we present the learning process, learning outcomes, and facilitators of the learning process.

Learning process: Interacting with and in context

Trainees learned by engaging in real and simulated public health contexts focused primarily on acute infectious diseases (see Fig. 1). These contexts involved interactions with people, data, systems, and knowledge through practical assignments, simulations, discussions, case studies, routine work, projects, and field investigations. Trainees applied existing knowledge and strategies to navigate the situation, reinforcing, revising, or identifying gaps in knowledge. For example, in an investigation of antimicrobial-resistant pathogens, the following narrative features ZY's interactions with teammates, advisors, and hospital staff and shows how ZY's knowledge and strategies evolved.

> *Listening to and smoothing communication to control disease—ZY (second-year trainee): [T]he most memorable thing for me was that I thought I had no idea about clinical work (...) I didn't know what nurses do in a hospital (...) So, I think the most important thing I learned was to hear about their work (...)*
> *In the first place, the [advisors] taught us in advance what they are going to ask about when interviewing in the investigation of hospital-acquired infections, and we also prepared an interview guide. Then, we followed the guide during the interviews. I think that learning about those interview processes was an important outcome of FETP.*
> *So, we asked the nurses about how they usually manage infection control in the hospital wards (...) I conducted interviews with the [teammate who] specialized in [nosocomial infections] and the [advisor] and the other FETP trainee, who has clinical experience, collected the information from electronic medical records. I think it would have been difficult if the person in charge of electronic medical records did not have any experience using [the records system. . .] I think we were able to collect information efficiently (...)*

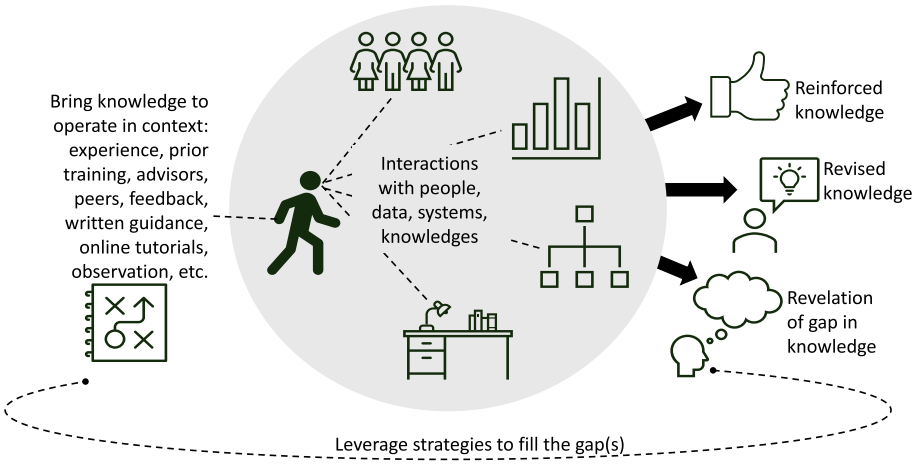

Fig. 1 The FETP learning process: trainees interact with public health contexts to construct knowledge

I didn't really have much awareness of the problem of hospital-acquired infections in the first place (...) I heard from the nurses on site that although the nurses and others on site were working very hard, [management and other staff] were not really responding (...) The [advisor] said something like, '[FETP] does conduct field investigations and speaks for the infection control staff and nurses—what they want to tell [management], what they want to see done. It is one of our roles to facilitate smooth communication' (...)

The drug resistance issue was very new to me personally, and I was able to learn a lot about it in terms of general knowledge. The other thing I learned was that the FETP's work, or the impact or role of field investigations, is that sometimes we are called upon to help smooth out a situation where a solution is already there in the field, but something is not going well.

Narratives about learning took place mostly in real contexts (e.g., presenting to stakeholders, checking mosquito traps, and evaluating a surveillance system). Occasionally, they occurred in simulated contexts in courses (e.g., case studies, role plays). All narratives involved interactions with people, data, systems, or knowledge. For example, ZY (above) interacted with hospital staff, teammates, patients, data systems, hospital systems (e.g., staff responsibilities, infection prevention and control), and knowledge of these systems, data, and antimicrobial resistance; GG's research project (below) involved interactions with advisors, stakeholders, and data owners while navigating the challenges of traffic accident data systems and the knowledge of them and of research methods.

Seeing research with a new perspective—GG (first-year trainee): [I]t was difficult to get data on [traffic] accidents, even though I work for [this] organization. The (...) data cannot be given directly because it contains personal information [. . .so] it was a little difficult to get that data from the specialist in charge (...) Also, it was difficult to make a conclusion [based] on that [traffic accident] number alone (...) In addition, [. . .] it was difficult to put the [material from the] biostatistics course into a real environment and use it (...)

Prior to the project, GG had aspired to present at the provincial academic research conference but lacked confidence in research methods. Learning through the project gave GG a new perspective on that conference.

GG (first-year trainee): I had thought about doing research before, but my knowledge was lacking. When I wanted to do research, I read it in a book, but I didn't understand it (...) This year, [the] academic conference was held (...) [I realized the] entire process of [the researchers'] detailed research work (...) seems to be very lacking. So, I am very happy to have studied in [FETP. . .] I learned everything about the rationale, goals, and objectives in [FETP] this year and acquired a small amount of knowledge [. . .] I think that there was a lot of effort to improve and show my knowledge in front of people (...) I improved a lot and showed my knowledge proudly in front of people [at the project defence].

As shown in ZY's and GG's narratives, field investigations and projects provided the impetus for contextual engagement. Trainees applied existing knowledge (e.g., medicine, public health, software programmes, laboratory diagnostics) to navigate these contexts. Their

strategies included building relationships; leading; observing or shadowing; consulting advisors; obtaining feedback; reading guidance, textbooks, manuscripts, etc.; viewing online tutorials; collaborating with advisors; seeking peer support; and trying and erring. ZY sought guidance from a peer, talked with hospital nurses, took advice from advisors, and followed an interview guide to navigate the investigation, whereas GG applied knowledge of research, national data sources, and biostatistics (developed in FETP), took advisors' advice, read, and prepared to answer stakeholder questions.

As trainees applied knowledge, they reinforced it, revised it, or identified gaps in it. ZY revised the knowledge of interviewing, clinical practice, antimicrobial resistance, and the role of field epidemiologists. GG revised the knowledge of research methods, motor vehicle accidents, and presentations. AB described a knowledge gap in the data that surfaced in this project:

> *Not just data analysis—AB (second-year trainee): You expect everything to go fine and smooth, the data to be 100% complete (...) But, you know, so if you were just doing the data analysis with the dataset that you were provided [. . .you're] just a data analyst, not an epidemiologist (...) Like having a research question and then able to answer with what resources you have, what dataset you have, and with the limited resources—if you can answer that research question, I think you would be a nice epidemiologist. That's what I learned here.*
> *(...) I normally meet with my [advisors], and then when I present the data in tables and figures, I'm questioned, like, 'Does it make sense? So, what is the data missing?' (...) So that's what I learned: like, okay, so I should have some answers (...) to address those questions (...) So, for that, I need to understand like the surveillance system in place as well (...) Like, what's the surveillance system? [. . .] And when did it start? (...) So, I need to understand and work with people (...) who have access to that data and who had been in that department for many years (...)*
> *So, yeah, so the question started from my [advisors]. Then, that's what widened my horizon. Okay. I need to be, need to be investigating further. It's not just data analysis.*

To address knowledge gaps, trainees employed similar strategies (i.e., building relationships, leading, observing, etc.). AB read documents and consulted colleagues. ZY sought advice from peers with clinical backgrounds. GG read and consulted the advisor. Although trainees had preferred strategies, they adapted them to the situation.

Learning outcomes

Trainees learned more than technical knowledge. Table 4 summarizes the learning outcomes described in trainee interviews, including improvements in knowledge of public health systems, communication, relationships, and decision-making, as well as changes in perspective, in understanding the meaning of field epidemiologist, and in the value of field epidemiology. Some advisors said that the most important outcome was for trainees to know how to handle outbreak investigations. While other types of knowledge, such as surveillance and research, were important, advisors saw them as supporting the ability to handle an investigation. Few trainees had multiple opportunities for field investigations, and still fewer in this study led one.

Table 4 Learning described in interviewed trainee narratives on their experiences with the FETP in Australia, Japan, Mongolia, and Taiwan

Learning described in trainee interviews
Meaning—of 'field epidemiologist', value of field epidemiology.
Perspective—awareness of community and population (compared to patient), thinking like an epidemiologist, differences between clinical and public health work, institutional and sociopolitical contexts surrounding investigations.
Public health systems—players, roles, and relationships, importance of networks for controlling disease.
Surveillance—operations and limitations, diagnostic testing and clinical practices to interpret surveillance, how data are generated.
Data gathering—interviewing, communication with cases and stakeholders to obtain data, environmental sampling.
Analyses—statistics, software programmes, data cleaning, case definitions, when to conduct thorough versus 'quick and dirty' analyses.
Outbreak response—steps for investigating, reasons for investigating, how to change one's alertness based on event, transmission and control of specific diseases, infection prevention and control.
Communication—preparing and presenting reports, interacting with cases and stakeholders, moderating discussions, knowing how, when, why and how much information to share, knowing risk communication, telling stories with data, turning numbers into sentences.
Interpersonal relationships—building relationships, networking, knowing whom to engage for consensus-building or data collection and how, participating in teams, leading teams, valuing teamwork.
Decision-making—considerations of stakeholder perspectives and institutional reputations, how to work with unclear guidelines and instructions.

Facilitators of the learning process: learning environments, advisor stewardship, trainee tenacity

Learning environments

Narratives illustrated learning experiences primarily in routine placement work, projects, field investigations, and intensive courses. We use the term 'learning environments' to reflect that these settings did more than provide a backdrop; they facilitated learning by providing context and purpose for interaction with reduced risk. By 'risk', we refer to the potential consequences of trainee error. Routine placement work included daily and ad hoc assignments that trainees performed in their placements (not described in the Mongolia FETP). The projects included epidemiological studies; surveillance data analyses; and surveillance evaluations in Taiwan, Japan, and Australia. For field investigations, trainees deployed in teams to investigate predominantly acute public health events, e.g., in communities, military institutions, mining sites, and hospitals. Intensive courses were introductory and short courses with FETP staff or subject-matter experts at host institutions and local universities leading them.

For example, JS learned that communication in public health involved knowing the audience and delivering clear messages to ensure appropriate and meaningful actions. The trainee linked this learning to multiple experiences in routine placement work, small events that accumulated through repetition, where JS had to convince clinicians, laboratory personnel, and public health workers to share data, order tests, and take action. Immediate feedback from the success or failure of these interactions informed learning. Similarly, HK learned the limits of surveillance through a project evaluating a surveillance system. *'[Each trainee] evaluates the surveillance system of one disease from various perspectives, which is both work and study. I think I learned the most about the mechanisms and limitations of surveillance through this activity*' (HK, second-year trainee).

Table 5 presents the characteristics and common trainee tasks, roles, and motivations for each learning environment. Although all FETP activities involved learning, each environment balanced learning and practice to a different degree. Routine placement work, projects, and field investigations focused on learning through practice, while intensive courses relied on knowledge transfer through didactic and interactive methods. Each learning environment had a distinct timing and feedback characteristic. Trainees interacted with advisors in all environments and with experts in three. Interactions with other groups differed by environment. Advisors reduced risk in routine work, projects, and field investigations by supervising, assigning tasks, selecting topics, and preparing

Table 5 Comparison of FETP learning environments that facilitate learning

	Routine Placement Work	Projects	Field Investigations	Intensive Courses
Setting	Workplace	Workplace	Field	Classroom
Learning orientation	Practice	Practice	Practice	Knowledge transfer (didactic, interactive)
Timing	Short-term, repetitive, often ad hoc	Long-term, flexible	Acute, often urgent	Scheduled and finite
Modality	Individual or group	Individual or group	Group	Group
Supervision	Yes	Yes	Yes	No
Feedback	Immediate, performance-based	Periodic, final assessment	Varies	Little to none
Interactions with	Peers, advisors, workplace teammates, data owners, other professionals	Advisors, experts, data owners	Advisors, experts, public, stakeholders, teammates	Advisors, peers, experts
Trainee tasks or roles	Attend meetings Monitor disease reports Describe/assess trends Develop reports Conduct ad hoc analyses Assess risk Follow up cases/events Take part in field activities, e.g., restaurant inspections, mosquito prevention	Design and manage 3 – 4 projects Review literature Collect, clean, analyse data Interpret findings Draft and present reports	Design questionnaires Take notes and photographs Interview cases and staff Abstract data from patient charts Construct line lists Analyse data Review literature Develop and present reports Lead (seldomly)	Take notes Complete exercises Discuss with peers Take part in group work
Trainee motivations to engage	Contribute to team or public health Show capabilities and belongingness to team	Affect public health Deepen issue knowledge Demonstrate capabilities Fulfil requirements	Impact public health Find a solution	Learn skills and knowledge Meet peers

trainees before sending them to non-FETP settings. Trainee motivations to engage in learning environments were mostly about contributing, showing competence, and learning.

Learning experiences in intensive courses were mixed. Trainees expressed frustration more often at didactic sessions. A few identified new subjects, tools, and terms in lectures as 'interesting' and starting points for independent learning. Many felt confused, overwhelmed, or disconnected. During participant observations, trainees often appeared to disengage from lectures after twenty minutes. The accessibility of guest lecturers and their understanding of trainee needs were issues for some, whereas nonnative English speakers struggled with epidemiological terms and presentations in English. Interactive sessions helped some trainees understand field epidemiology and its relation to public health. Some trainees also appreciated meeting peers and identifying their own contributions and knowledge gaps.

> *A bit of a blur—BD (second-year trainee): I wouldn't say there was a whole lot of collaboration going on in [the course]. It was more guest speakers coming in and doing their bit and leaving, um, which is great because you get different people's expertise but not—because you get a lot of people who may have variable levels of investment in your [laughs] future and your career (...) But yeah, I don't know, it was a bit of a blur. All the [course sessions] were full on and then over quickly.*
> *Forgetting the next day—SG (first-year trainee): [Dr H] taught us topics related to what is frequency, mean, correlation, etc., for five days. We understood at that time. When he gave a case, [we could] find the average: what is the frequency? Find the [relative risk]. Find the [odds ratio], etc. But we forgot the next day when he re-asked again from us. Therefore, to be more productive (...) we should have sat and [studied] ourselves.*

Trainee tenacity

Trainee motivation, perseverance, and resourcefulness emerged as key factors for learning, which we termed 'tenacity'. Most trainees cited the COVID-19 pandemic as influencing their decision to join the FETP, whereas some highlighted improvements in knowledge, contributions to public health, and advancing their careers (e.g., obtaining certificates, connecting with the alumni network, and securing overseas work). Above, we described motivations for engaging in learning environments (see Table 4), which were essential for accessing learning opportunities. Difficulties arose, however, (e.g., accessing and interpreting data, accessing resources in the native language, applying standard concepts to diverse contexts, lacking access to advisors) that required perseverance and resourcefulness. These qualities helped trainees stay engaged in learning (see ZY and GG narratives). Advisors described these qualities as 'acting on their own ideas', being 'ready to bear the load', showing 'eagerness to learn', and 'love for the profession'. One advisor said, *'With the passion, they can complete everything. They can overcome everything if they have some passion'* (ET, advisor). When asked about trainees without passion, ET responded, *'They need more (…)—every time, we need to say the same thing (…) because they do not want to learn from us (…)—they don't hear our voice.'*

> *An unexpected learning resource—KG (first-year trainee): It was really difficult to work on a topic where there was no one to ask (...) I couldn't find anyone [in this country] who knew to ask (...)*
> *I was able to get information [from a social media website]. There is an epidemiology group [there . . .] A student [in the group] from [a foreign university] contacted me, gave me articles and books, and gradually supported me. There was a language barrier for me when I read the provided books. I don't understand the [topic in] English (...) So, to understand and read in [my language], there were a lot of difficulties (...), many scientific terms, which are difficult to understand in English for a person who does not fully understand [one's own language . . .]*
> *Interviewer: (...) How much effect did the [research project] have on your work?*
> *KG: (...) There is no longer a situation where our [advisors] criticize me because [now], they say I will do good research [. . . and they] have [sent me] requests to [teach] in this field (...) I aim to conduct [training] after gaining in-depth and comprehensive knowledge. Currently [I am] reading a lot of textbooks.*

A few narratives illustrated where more tenacity might have aided learning. In one example, a trainee attempted to learn a statistical programme with multiple resources (i.e., following a handbook, planning, watching an advisor, doing exercises, joining a peer group) but lacked a project that required the software, lost motivation, and stopped. The trainee explained that there was 'no angle' or 'no goal', so the trainee shifted focus to other priorities. Another trainee narrated the story of SI, a trainee from the cohort who left the programme. SI worked another job while taking part in the introductory course and had difficulty meeting with the assigned advisor. When SI was to present the research project, he felt unprepared to answer the panel's potential questions and thus did not go.

Advisor stewardship

Trainees interacted with advisors in contexts more than with any other group, relying on them to navigate contexts and bridge knowledge gaps. Advisors shaped trainee learning by determining assignments, roles, and responsibilities and managing the risks of trainee error. As illustrated in this next example, they connected trainees with context. In addition to supervising or training, advisors stewarded learning.

> *Learning more than investigation—NU (second-year trainee): I don't have much experience [in the hospital], and it's a very complicated setting (...) because (...) they have a lot of patients, and (...) they have a high workload. They always feel stressed, and it's very hard to work with them. So, if they do not collaborate with me, it will be very challenging for me to get the data (...)*
> *So, mostly if we want to work with the stakeholders in [this country], I will get the advice from my [advisors] because they have many experiences working with different settings, especially the hospital. So before working with [the stakeholders . . .] the connection is very important. So, one of my [advisors] helped me to connect with the leader of the [hospital. . .] And if the leaders have some agreement about conducting the kind of study, they will like support us to have some meeting, have some discussion and then (...) we will work closely to try to do something like this.*
> *And from many times I have to go to the hospital to collect the data, I realize that I have to [be] familiar with the schedule of the doctors (...) because in the morning they will [be] very busy (...)*
> *And it's very hard to try to balance the benefits between two organizations because (...) they want to have some kind of benefit for the article of the clinical side. And from my side, I want to finish my [investigation] but focus on the epi descriptive analysis (...) I have to discuss a lot with my [advisors], and they advise me [. . .to] propose some kind of solution (...) So, I learn how to work with the hospital and how to try to balance the benefits between the different organizations.*

Discussion

We explored learning in four FETPs via qualitative methods and found that trainees learned through interactions with people, data, systems, and knowledge in real and simulated public health contexts. Four learning environments emerged: routine placement work, projects, field investigations, and intensive courses. Advisors stewarded learning by shaping opportunities, whereas tenacity enabled trainees to navigate challenges and remain engaged. Through these processes, trainees learned the necessary technical knowledge and tacit knowledge to apply it in practice.

Foundational and contemporary constructivist theories support our findings by emphasizing the role of interactions with environments in learning. Piaget [28] argued that knowledge is constructed through environmental interactions, leading to equilibrium or disequilibrium and triggering schema assimilation or accommodation. Vygotsky [29] highlighted the importance of social interactions mediated by cultural tools, especially language internalized as thought. Kolb [30] described learning as a cyclical process of experience, reflection, conceptualization, and experimentation. Illeris [31] proposed a triangular model where environmental and psychological processes interact, with content and incentives shaping learning. Together, these theories underscore that learning involves interpreting and revising knowledge through engagement with the environment.

Among the four learning environments identified, routine work emerged as the most robust, whereas intensive courses were the least, suggesting that some environments may facilitate learning more than others. Taber and colleagues similarly reported that paramedics and firefighters understood their professions through practice despite extensive courses [32]. In our data, interactive approaches seemed to foster more learning than did didactic methods in intensive courses. Such a finding—given the resources invested in FETP curriculum development (for example, [33–35])—implies misalignment that merits exploration.

Multiple factors could explain differences across learning environments. Trainees spend more time in routine work, projects, and field investigations than in courses. Additionally, they may be less likely to remember course experiences in interviews because years of schooling could have made them accustomed to such environments. Less learning and greater difficulty are also expected early in training, when trainees are mostly in courses. Additionally, FETP lectures seldom include follow-up activities, unlike most secondary and university courses, which incorporate exercises or essays to reinforce learning.

We argue instead that routine work, projects, and field investigations facilitate learning more so than courses by immersing trainees in the practice of field epidemiology, allowing them to grasp its meaning, knowledge, and competence. Lave and Wenger's theory of legitimate peripheral participation in communities of practice [36] supports this claim. It posits that learning is a social process situated in the everyday activities of a community

of practitioners. Newcomers progress from peripheral toward full participation, acquiring knowledge and competence through interaction with the community's learning resources. This theory, developed through studies of apprenticeships in health and non-health professions, has also been applied to learning in firefighters and paramedics [32] emergency room residents [37], and probationary constables [38].

Lave and Wenger [36] argue that knowledge is not inherently 'abstract' or 'concrete' but that a separation arises when newcomers are sequestered from practice, forced to interact with knowledge disconnected from practice. This explanation resonates with FETP trainees in this study who felt overwhelmed or disengaged during courses. Freire's 'banking concept of education' similarly critiques this disconnect, advocating for praxis—integrated theory and practice [39]. Campbell's study of police newcomers also concluded that relegating trainees to observation ignores their prior knowledge and reduces enthusiasm. The authors recommend more opportunities for involvement in diverse environments and bridging the gap between the training institute and field [40].

Lave and Wenger [36] propose facilitating access to the community of practice (COP), including its activities, members, resources, tools, and opportunities to participate. Through legitimate peripheral participation, newcomers learn not through abstract curricula but modified forms of participation that open the COP to them [41]. Wenger clarifies that participation fosters learning because through it knowing and learning align, the nature of competence aligns with the processes of acquiring, sharing, and extending competence, so learning through participation is epistemologically correct [41].

Facilitating newcomer access to practice, however, requires peripherality and legitimacy [41]. Peripherality allows newcomers to take part with reduced responsibility, risk, intensity, complexity, or cost of error, while legitimacy—such as recognition as an FETP trainee or mentorship from an experienced field epidemiologist—acknowledges newcomers as potential community members despite their inability to demonstrate competence. These concepts highlight the critical role of advisor stewardship in FETP learning through managing peripherality and bestowing legitimacy.

In summary, learning always occurs, but its nature depends on what and how trainees engage. Engaging in lectures leads to learning lecturing; engaging in field epidemiology practice leads to learning the practice. Routine work, projects, field investigations, and advisor stewardship provide the peripherality and legitimacy needed to open the practice to trainees.

While legitimate peripheral participation explains how learning environments and advisor stewardship facilitate learning, it also raises concerns. First, when learning occurs inherently through social processes, training design risks becoming futile. Second, the COP may be reified too much, prioritizing 'joining the club' over the practice itself. Indeed, a few trainees in this study admitted joining FETP 'for the connections', 'to work overseas', or for the 'official certificate'. Some stopped routine work or declined field opportunities to draft reports for graduation, which their advisors encouraged. Third, the COP may overlook, ignore, or exclude those who do not fit its worldview. Nicolini and colleagues' review of COP literature highlights that power struggles in COPs can hinder knowledge sharing, defend entrenched power structures, and delegitimize outsider perspectives [42], which could homogenize FETP trainees and alumni and obstruct innovation and adaptation to a country's dynamic needs. Among our participants, nonnative English speakers and women with caregiving responsibilities reported additional challenges, raising concerns about inclusivity, especially given FETP's mandate to serve diverse communities and achieve a multisectoral One Health approach.

To address these concerns, we suggest three approaches. First, ensure trainees have diverse opportunities to engage in legitimate peripheral practice by leveraging the peripherality and legitimacy of routine work, projects, field investigations, and advisor stewardship. Second, members of the COP should be regularly involved in defining the practice and what trainees must demonstrate to join the COP and in clarifying how they will engage trainees at the periphery. Although community members are mostly national FETP alumni, those who take other paths to field epidemiology should be included. Third, reflect and clarify with COP members why the FETP wants trainees from diverse backgrounds and then ensure that trainees from diverse backgrounds have sufficient learning resources (linguistically, socially, professionally, culturally, etc.) and advisor stewardship for legitimate peripheral participation. Check in regularly with trainees to know what they need.

We do not advocate removing intensive courses from FETP. Trainees in this study valued meeting peers, identifying learning resources, and obtaining initial images of field epidemiology. Interactive sessions such as case studies helped trainees achieve these outcomes. Courses can be useful for simulated practice (e.g., interviewing cases, analysing messy data, negotiating findings with stakeholders). The foundational FETP relied on case studies to introduce the discipline, although most learning occurred in two-year placements [15]. Wenger, too, emphasizes that classroom instruction is not useless but that it should supplement the inherent learning potential

of practice, not substitute it. He suggests grounding courses in practice by interspersing information sharing and reflection sessions with peripheral engagement in real-world settings instead of front loading with classroom training [41].

A last important finding is the role of trainee tenacity in learning. The motivation to join FETP and the motivation to engage in specific tasks helped trainees engage, whereas perseverance and resourcefulness helped them learn through difficulty. Goldman [37], studying emergency medicine residents, also reported that high motivation and self-direction were required for learning. Harris and colleagues reported that self-initiating skills were important for building police constables' confidence and competence [38]. Illeris specifies incentive, including feelings, emotion, volition, and motivation, as an important dimension providing and directing the necessary mental energy for learning [31]. For Lave and Wenger [36], motivation is at the core of the theory. It drives trainees toward full participation. Wenger explains learning as an experience of identity rather than an accumulation of skills and information because learning transforms who we are and what we can do. So, it is a process of becoming and a source of meaningfulness and energy [41]. His explanation resonates with trainees who want to perform well in front of others, improve technical abilities, or fulfil their perceived professional needs. In contrast, two study participants did not complete their programmes, and their reasons were a preference for another COP or different identity. Programs would thus do well to look for tenacity when selecting trainees, to clarify the importance of tenacity with trainees at the beginning, and to cultivate tenacity throughout the programme. Research into selecting and cultivating tenacity in adults would benefit these efforts.

A few strengths [23, 43] of our method are notable. First, we codesigned and co-interpreted this research. The inclusion of lead advisors from the programmes helped reduce bias and ensure that the questions and findings were meaningful to the programmes. Periodic review of data with these advisors increased verisimilitude, validity, and trustworthiness. Second, the high number of trainee interviews, follow-up interviews with most, and participant observations allowed for the triangulation of findings across data sources, further increasing validity. Finally, including multiple programmes with diverse characteristics reduces the likelihood that these findings are driven by one individual, country, culture, or programme.

Two key assumptions underlie our analysis. First, learning reflects a change in knowledge or perspective [28, 29]. While such changes may lead to behaviour modifications, other factors influence behaviour, so we focused on changes in knowledge and perspective as evidence of learning outcomes. Second, learning links with memorable moments that have a lasting impact on understanding and action [30, 44] especially within a one- or two-year programme. We prioritized these moments as evidence of learning.

Our study of four programmes does not represent the diversity of FETPs. We did not include Frontline FETP or low-income countries, and we were unable to recruit advisors from Australia's programme (the only university-based programme in the study). Therefore, caution should be used when these findings are applied. Nevertheless, this study provides the first systematic description of the learning process in FETP, which can be built upon through research and practice to scale efforts for emergencies, adapt FETP to new contexts, balance global standardization and local needs, inform measures of learning and evaluation, and align training with modern adult learning theories.

Conclusions

We have shown that learning in FETPs occurs through trainees engaging in public health contexts, being stewarded by advisors and driven by tenacity. The identification of these key components suggests that countries in diverse resource settings have the tools to build field epidemiology capacity and public health leadership. To sharpen such tools, governments, partners, and programme leaders should focus on enhancing learning environments, ensuring advisor accessibility, and fostering a culture of tenacity among trainees. Future research should focus on cultural context, advisor stewardship, and trainee tenacity. FETP is among the strongest tools for national, regional, and global health security; we cannot let the next pandemic arrive before fortifying it with smart investments.

Abbreviations

CDC (Taiwan)	Taiwan Centers for Disease Control
COHFE	Competencies for One Health field epidemiology
COP	Community of Practice
COVID-19	Coronavirus disease 2019
FETP	Field Epidemiology Training Programme
NA	Not Applicable
SARS-CoV-2	Severe Acute Respiratory Syndrome coronavirus 2
TEPHINET	Training Programs in Epidemiology and Public Health Interventions Network
US CDC	United States Centers for Disease Control and Prevention
USA	United States of America
WHO	World Health Organization

Supplementary Information

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Supplementary Material 1.

Supplementary Material 2.

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Authors' contributions
MMG contributed to the conception and design of the study, conducted participant observations and interviews, analysed and interpreted data, and drafted and revised the manuscript. EF contributed to the conception and design of the study, interpreted data, and provided input on the manuscript. ASH contributed to the conception and design of the study, interpreted data, and provided input on the manuscript. TS contributed to the conception and design of the study, interpreted data, and provided input on the manuscript. MB contributed to the conception and design of the study and interpreted data. TH contributed to the conception and design of the study and provided input on the manuscript. BP contributed to the conception and design of the study, interpreted data, and provided input on the manuscript. MDK contributed to the conception and design of the study and provided input on the manuscript. All authors have approved the submitted version and have agreed to be personally accountable for the author's own contributions and to ensure that questions related to the accuracy or integrity of any part of the work are appropriately investigated, resolved, and the resolution documented in the literature.

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Data availability
The datasets generated and analysed during the current study are not publicly available due to individual privacy and confidentiality but are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
The Australian National University Human Research Ethics Committee (2021/771) and the Institutional Review Board of Centers for Disease Control, Ministry of Health and Welfare, Taiwan (112206), approved this research. No additional institutes required ethics review. Consent was obtained from programme directors for participant observation after discussion with participants, who could opt out. Interviewees consented to participate individually.

Consent for publication
All included interview transcript data has been anonymised as much as possible. Participants whose transcript data are included in the manuscript had the opportunity to review the text and provide consent.

Competing interests
The authors declare no competing interests.

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Publisher's Note

Chapter 6 THE CRITICAL ROLES OF ADVISORS IN STEWARDING THE PERIPHERY OF THE FIELD EPIDEMIOLOGY COMMUNITY OF PRACTICE

. . .[I]n the past, I thought that this is only outbreak investigation, but now [I see it as] learning everything—how to survive in life. . .This is their [i.e., the trainees] life. So, if they do not learn anything about outbreak investigation, it is okay if they learn something in the field.

— senior FETP advisor, Japan

In Chapter Five, I concluded by urging research into cultural contexts, advisor stewardship, and trainee tenacity. I felt that clearly describing the learning process and its main facilitators was essential before addressing deeper questions about learning in FETP. Now, it was time to do the deeper analyses.

Cultural influence was one of the main areas of interest for me at the beginning of this thesis. So, I had hoped to explore it, but discussions with coresearchers and supervisors led to selecting *advisor stewardship*. Coresearchers saw it as a more feasible element to influence to enhance learning. They, my supervisors, and I also suspected that cultural influences would emerge in the study of advisor stewardship.

As I reviewed the narratives on advisors and advisor-trainee interactions, comparing and categorizing them—in what became an unexpected return to grounded theory—I began noticing and distinguishing activities (i.e., what the advisors did) and approaches (i.e., how advisors operated with trainees). Separating these led to the construction of a spectrum of approaches (now, modes of engagement). Discussions with coresearchers led to refining the spectrum.

Because I had already found strong coherence with Lave and Wenger's work (Lave & Wenger, 1991; Wenger, 1998) in explaining learning processes in FETP, I applied it here to interpret the findings. Again, their work proved essential to understanding learning in FETP. I submitted a manuscript on advisor stewardship to an international peer-reviewed journal in December 2024.

This chapter presents the submitted—now revised—manuscript. In it, I explain three dimensions of advisor stewardship through the lens of Lave and Wenger and introduce a six-point spectrum of modes of engagement, influenced by culture and situational factors. These findings illustrate how FETP *is* the periphery of the field epidemiology COP and underscores the importance of advisors for stewarding that periphery. I conclude by recommending programs to invest in advisors in three clear ways.

Stewarding the periphery: A qualitative analysis of advisor roles in field epidemiology training programs

Abstract

Background: Field epidemiology training programs (FETPs) play a critical role in public health and offer an intriguing educational context. Recent research has highlighted 'advisor stewardship' as a key facilitator of the FETP learning process. **Methods:** This qualitative study explored the dimensions of FETP advisor stewardship through a codesigned analysis of trainee-advisor interactions in four FETPs in Australia, Japan, Mongolia, and Taiwan. Using constructivist grounded theory and narrative inquiry, we analysed participant observations and semi-structured interviews with trainees and advisors, guided by Lave and Wenger's concept of legitimate peripheral participation in communities of practice. **Results:** Our analyses identified three dimensions of advisor stewardship: managing peripherality through role and responsibility assignment, bestowing legitimacy by laying groundwork, and interacting with trainees via adaptive modes of engagement. A six-point spectrum of engagement modes ranging from hands-off to hands-on fit the data. Advisors employed these modes flexibly, influenced by cultural and situational factors, to build trainee competence. **Conclusions:** This study introduces a novel spectrum of advisor engagement modes and underscores the dual roles advisors play in building competence and stewarding the periphery of the field epidemiology COP. By extending Lave and Wenger's framework, the findings highlight the importance of investing in FETP advisor capacities, ensuring adequate advisor-to-trainee ratios, and using the spectrum to inform program design and evaluation rather than creating new curricula.

Background

Field epidemiology offers fascinating opportunities for educational exploration. While it shares epidemiology's focus on systematically identifying patterns in diseases to suggest causes, its primary goal is 'to guide, as quickly as possible, the processes of selecting and implementing interventions to lessen or prevent illness or death' (Goodman et al., 2019, p. 3). Field epidemiologists typically achieve this through

surveillance and outbreak investigation, with challenges that include limited data, drawing conclusions from small samples or insufficient specimens, and navigating local stakeholder and public attention.

The principal mechanism for developing field epidemiologists is the Field Epidemiology Training Program (FETP). This service-based, hands-on training program emphasizes learning by doing, typically combining a didactic course (25% of time) and a 'field' (i.e., worksite) placement (75%) in a public health setting like a health department or the ministry of health. FETP drew its model from USA's Epidemic Intelligence Service, which began in 1951 (Foege, 1996). There are now nearly 100 FETPs building capacity in over 200 countries and territories (TEPHINET, 2023).

While most research on FETP focuses on program outcomes, recent work has begun exploring learning processes within these programs. We conducted a qualitative study of four FETPs in Australia, Japan, Mongolia, and Taiwan, finding that trainees learn through engaging in public health contexts, interacting with data, systems, people, and knowledge. Key facilitators of this learning process include learning environments (routine placement work, projects, field investigations, and courses), trainee tenacity, and advisor stewardship (Griffith et al., 2024a, 2024b). Interpreted through Lave and Wenger's legitimate peripheral participation in communities of practice (Lave & Wenger, 1991; Wenger, 1998), the study highlights how FETP immerses trainees in the practice of field epidemiology through legitimate, peripheral tasks that construct competence, foster meaning-making, and support integration into the field epidemiology COP.

This article's analysis aims to extend the understanding of FETP learning by exploring advisor stewardship from historical, theoretical, and empirical perspectives. We used the term 'advisor' for trainers, mentors, facilitators, and supervisors because each program used different terms, and the same people often performed multiple roles. While the term 'stewardship' has not been used in FETP published literature, comparable terms lack clear definitions. For instance, Alexander Langmuir, founder of the foundational FETP, 'believed strongly in *mentoring to provide checks and balances* [and so] no one was sent into the field without *supervision* from their home base' (Schaffner & LaForce, 1996, p. S19, emphasis added). Fifty years later, an evaluation of ten FETPs assessed the frequency and method of advisor-trainee contact per outbreak

investigation and the number of program work product drafts exchanged (Jones et al., 2014). The authors highlighted variability in *advisors'* roles and the need for clearer guidance on high quality *supervision*.

More recent research has explored effective supervision in FETP across the Asia-Pacific region (Forbes et al., 2019). FETP supervisors, mentors and resident advisers rated activities such as *ensuring exposure to outbreaks*, *teaching techniques and concepts*, and *ensuring appropriate trainee responsibility* as highly effective supervisor activities. Activities rated as highly positive for field supervisors included helping the trainee negotiate organizational/logistical issues and develop professional networks and providing opportunities to develop technical and interpersonal skills without teaching them. The authors suggested that supervisors' key roles lie in facilitating trainee-directed learning and opportunities for practical application rather than didactic instruction—aligning with Knowles's (1989) 'facilitator of learning' more than the traditional definition of a 'supervisor' who oversees the work or conduct of a person (Oxford English Dictionary, 2024). Forbes and colleagues (2019) call for research into FETP supervision, especially through trainee perspectives. Similarly, Birkeli and colleagues' (2023) scoping review on educational supervision in internal medicine residency training found no universal definition, a weak theoretical foundation, and lack of empirical studies, particularly regarding the term's distinction from related terms like 'mentoring' and 'feedback'. These gaps underscore the need for greater clarity into what FETP advisors do.

The concept of 'advisor stewardship' is grounded in Lave and Wenger's theory of situated learning in COP (1991; 1998). This theory posits that learning is a fundamentally social process, occurring through participation in the everyday activities of a community of practitioners. Wenger (1998, p. 102) explains that practice 'is not an object to be handed down from one generation to the next' but is learned as communities reproduce membership by integrating newcomers and having them interact with experienced members. In field epidemiology, this generational progression involves trainees becoming junior field epidemiologists, juniors becoming mid-career ones, and mid-career ones becoming seniors. Learning across generations is effective because it relies on 'epistemologically correct' educational processes, where newcomers develop competence in the same ways experienced members do,

i.e., through interaction and the negotiation of meaning (Wenger, 1998, p. 101). Critical to this process is ensuring newcomers have opportunities to interact with experienced generations. Gaining entry to a COP and to its members, however, can be difficult.

Lave and Wenger (1991) describe the process of becoming a community member as 'legitimate peripheral participation', a concept particularly relevant to FETPs. This term highlights that the learning occurs not through reified curricula but through modified forms of participation that open the practice to newcomers (Wenger, 1998). Wenger identifies two modified forms: peripherality and legitimacy.

Peripherality allows newcomers to approximate full participation while minimizing risk, intensity, or the cost of errors. Examples include close supervision, special assistance, and explanations or stories that are part of the practice and take place within it. Effective peripherality gives newcomers a sense of how the community operates by providing access to the three dimensions of practice: mutual engagement with members, members' actions and negotiations of the enterprise, and a shared repertoire of resources for negotiating meaning.

Legitimacy, meanwhile, ensures that newcomers are recognized as potential members because they are not likely to be fully competent yet. Without legitimacy, their errors and shortcomings will be grounds for dismissal. With legitimacy—achieved through sponsorship, relationships with established members, or recognition by role or title—such errors become learning opportunities.

In FETP, advisor stewardship plays the critical role of managing peripherality and bestowing legitimacy (Griffith et al., 2024b). Advisors shape learning by determining assignments, roles, and responsibilities; managing risks of error; and connecting trainees to the COP. These processes help trainees to interact with the community, construct competence, and become members themselves. In other words, advisors steward the periphery of the field epidemiology COP. This paper examines trainee-advisor interactions to explore the dimensions of advisor stewardship and clarify how advisors steward the periphery.

Methods

This study is part of a broader qualitative constructivist research project exploring training and learning in FETPs in Australia, Japan, Mongolia, and Taiwan. I have

summarized characteristics of these programs in Table 6.1. The protocol for the broader study has been published (Griffith et al., 2024a).

I codesigned the broader study with a lead advisor from each participating FETP. Data collection included five days of participant observation in Australia, Japan, and Mongolia. I observed advisor-trainee interactions during classroom sessions, project meetings, outbreak investigation planning, group project development, presentations, and surveillance meetings and engaged in informal discussions during breaks. As approved by the institutional review board at the Australian National University (2021/771), consent for participant observation was obtained from program directors after their discussion with participants, who could opt out of the participant observations. In such cases, no information was recorded about those individuals in the field notes.

Additionally, hired, trained, bi-lingual interviewers and I conducted one to three in-depth, semi-structured interviews (one to two hours each) with trainees and advisors. I developed the interview guides for this study and have provided them in Appendix B. Interview Guides. All interviewees provided informed consent to participate.

Table 6.1. Characteristics of FETP participating in this study.

Program	Australia	Mongolia	Taiwan	Japan
FETP Staff	8	4	3	6
Cohort (n)	16–25	6–10	<5	6–20
Advising	≥1 placement-based advisor and ≥1 FETP staff advisor for each trainee	2 FETP staff for all trainees and 1 volunteer alumni for each trainee	1 FETP staff assigned to each trainee (each staff with multiple trainees)	FETP staff assigned to trainees based on assignment topic(s)

Analysis began with open coding, following Charmaz's (2014) constructivist grounded theory. That process produced codes organized into four trees: core learning processes, contextual processes, developing field epidemiologists (advisor roles in trainee learning), and learning field epidemiology (trainees approaches to learning). For the second phase, focused coding, I coded larger sections of data in which interviewees were narrating or storying responses. I followed Polkinghorne's (1995, p. 12) definition of 'sustained emplotted accounts with a beginning, middle, and end' and plots as conceptual schemes that provide contextual meaning and integrate events into an organized whole. More simply, I defined stories as chronological sequences of events told in past tense about an identifiable situation. Coding stories distinguished generalized from specific responses: a generalized response, for example, was 'I always ask questions when I am confused', while a specific response was, 'I stumbled through my data analysis project and brought as many questions to my advisors as I could fit into our 45-minute fortnightly meetings'. These stories included evidence of the points that interviewees made and revealed their meaning, too. To accommodate diverse cultural and individual storytelling styles, I included complete stories with clear sequences and fragmented stories that required synthesis through probing or researcher interpretation.

Next, I drew from Polkinghorne's 'analysis of narratives'. I read the coded stories to identify their context, for example *introductory course* or *outbreak investigation*; their main action or movement, such as a change in the narrator's understanding or skill; what the story means; the supporting characters who helped or impacted the narrator or situation; and what was learned or not learned. I have provided four examples in Table 6.2.

Table 6.1. Analysis of narratives table with four examples.

Program	Trainee Year	Context	Story (main action, movement)	Supporting Characters	Trainee Learning
Australia	1	Projects	The process of designing the epidemiology research project, a key element for choosing the project was to have real community impact. The trainee struggled with the design but then recognized the project as a type of evaluation…	Advisors, statistician	To ask questions; to acknowledge gaps in knowledge when designing a study; to complete the ethics application; to use pre- post-evaluation designs
Japan	1	Routine placement work	A trainee learns through participation in morning meetings. No specific example provided but surveillance learning points named that the trainee relates to observing morning meeting interactions…	Senior advisors	What government agencies value; what speed and action mean for responding to surveillance signals
Taiwan	N/A [Advisor]	Outbreak investigation	The trainer reflects on [his/her] approach to training in the field, suggests an ideal approach, compares the two, recalls [his/her] approach while learning [as an FETP trainee] and concludes that…	Trainees learning from the advisor, advisor supervisors impacting decisions	Trainees learn the investigation steps; how to draft questionnaires; how to take lead in the field; how to interact with community residents and healthcare professionals
Mongolia	1	Project	The trainee works independently, struggles with health and family issues, for which the advisors adapt timelines. Trainee shares presentation with the advisors, who provide comments, which the trainee incorporates. One advisor with an open attitude helps with analyses and software programs…	Program advisors and individual advisor (‘mentor’)	Confidence to present and defend research; conduct background research; importance of biostatistics; how to use the software program

I then followed Polkinghorne's 'narrative analysis' and constructed case stories for each program by synthesizing the individual narratives. These case stories narrated how training and learning happens from trainees starting the program until finishing it. Due to confidentiality agreements with the participating programs, I cannot provide a worked exemplar of these case stories. I compared case stories with the remaining data (i.e., the non-STORYING interview transcripts and participant observation notes) to ensure consistency. I then reviewed each case story with the respective FETP lead advisor/coresearcher to assess verisimilitude and obtain their interpretations. Finally, I compared case stories across FETPs to identify common learning processes and their facilitators, which led to the emergence of advisor stewardship.

To explore advisor stewardship, I reviewed the narratives coded as STORYING again and coded them for advisor-trainee interactions. Narratives could be assigned to multiple codes, but those from INTENSIVE_COURSES (e.g., the introductory course) were excluded as beyond this study's scope. Some narratives lacked sufficient information for coding. Initial codes for interactions were COLLABORATING, ASSESSING, ASSIGNING, DEMONSTRATING, GIVING_FEEDBACK, INSPIRING, SUPPORTING, and LAYING_GROUNDWORK (i.e., connecting trainees with stakeholders or data for their projects and assignments). These codes revealed distinctions between specific activities (e.g., assigning and laying groundwork) and approaches to these activities (e.g., supporting and collaborating). I identified LAYING_GROUNDWORK and ASSIGNING as distinct processes separate from direct advisor-trainee interactions.

Upon reassigning narratives, I noticed a spectrum of engagement, with advisors exhibiting varying approaches that ranged from 'hands-on' to 'hands-off'. I synthesized the narratives within each code, reviewing them with the co-researchers and refining them by combining, separating, and renaming. Finally, I reviewed the narratives again to ensure consistency and identify factors contributing to advisor stewardship.

Results

We conducted 47 interviews: 1–3 with each of 6 advisors from Japan, Mongolia, and Taiwan and 19 trainees from all programs. Advisor characteristics are summarized

in **Table 6.3.**. Advisors with 2–10 years of experience I termed ‘senior advisors’, while those with fewer than two I termed ‘junior advisors’.

Two-thirds of the 127 identified narratives included descriptions reflecting advisor stewardship. From these narratives, I identified three dimensions: managing peripherality through role and responsibility assignment, bestowing legitimacy by laying groundwork, and engaging with trainees as experienced members of their communities of practice. Advisors adapted their modes of engagement to fit cultural and situational contexts.

Table 6.3. Characteristics of advisors who participated in interviews.

Advisor	Gender	Age Group	Highest Degree	Years as FETP Advisor
‘DW’	F	40 to <45	MD	<2
‘NG’	M	45 to <50	MD	2 to <10
‘BT’	F	35 to <40	MPH	2 to <10
‘CF’	F	35 to <40	MS	2 to <10
‘WS’	M	40 to <45	BS	2 to <10
‘RA’	M	45 to <50	MD	2 to <10

Managing peripherality to approximate the practice

Three learning environments provided opportunities for trainee peripherality: field investigations, projects, and routine placement work. Advisors approached these opportunities in diverse ways, balancing exposure to practice, peripherality, and broader social, cultural, and programmatic contexts.

Field investigations

Field investigations were the most discussed learning environment. Some advisors aimed to give trainees a complete investigation experience, foster good feelings about investigation, or encourage meaningful contributions. Advisors noted that increasing trainee autonomy enhanced learning, aligning with Wenger’s (1998) assertion that newcomers must gain insight into how a community operates. In the few examples where trainees had greater autonomy, advisors considered learning to be faster or more substantial. For example, ‘AN,’ a second-year trainee, led an investigation under advisor supervision after participating in multiple investigations. Of the experience, AN said, ‘I think I was given the opportunity to learn by taking the initiative as a leader [. . .] I think I could acquire what I've learned more by taking the

initiative'. Similarly, 'PP' took the lead when a nationwide epidemic stretched national epidemiologic capacity:

> **Forced to grow up—**
>
> *PP (second-year trainee): The [introductory] course hadn't finished, but everything had started. Yeah, that's what I mean, I think maybe I was forced to grow up [. . .] Because I [was] in such an environment—that is, it [was] not a good environment for training FETP trainees—because of insufficient manpower, because of the epidemic, so the training environment may not be so ideal [. . .] I think I had mastered this ability [to make a decision in the field] before my first year of FETP training was over, but what I want to say is that if the path I took was not like this, maybe I might only get familiar with it now.*

Examples of trainee autonomy were rare. Advisors in this learning environment had to balance facilitating peripherality while navigating stakeholder opinions, managing team dynamics, and ensuring appropriate investigation outcomes. Even when advisors sought to provide more autonomy, programmatic, social, and cultural structures often constrained them. In most narratives, advisors assigned investigation roles and responsibilities based on trainees' perceived capabilities, reserving high-risk tasks, such as discussing with hospital directors or presenting recommendations, for themselves. Typical trainee responsibilities included designing questionnaires, conducting interviews, abstracting and analysing data, and delivering presentations. Some advisors gradually increased autonomy, as seen with AN (above), while others used field assessment techniques to shift responsibilities or limited trainees to minimum program requirements:

> **They want authoritative voices—**
>
> *NG (senior advisor): In [this country], we like zero risk, zero risk. So, [here], it's tough for us to make or produce [the next generation] because in the field, the counterpart is not so happy of hearing from the trainee. They need—they want the voice of the authorities. This is another challenge for us. We need the result [of the investigation]. In that case, the trainee's voice is not so influential to them.*

A culture of concern—

RA (senior advisor, first interview): The role of [advisor] is actually. . .He just gives you a [palm moving forward in circles] suggestion, a bit like a coach—mentor—is, not to ask you to do something [. . .] actually [to] give [. . .] a lot of space. You can make your own decision, but of course you have to discuss with your [advisor. . .] I think there is [a benefit in that approach]. I think it is the speed of maturity, and the self-confidence of a [trainee], and whether he is willing to do this matter [. . .] The feeling here in [this country] . . .I don't know [pauses]. It seems that it is difficult to let go and [allow the trainees to lead] because there will be many people who will come to show [concern]. For example, my supervisor, and the people above him also care about it: 'Hey, what are you doing?' So, I don't know if it is cultural difference [looks aside. . .] Although I think that [trainees] should be allowed to do more, currently there seems to be no way to fully achieve this goal.

RA (continued in second interview): I don't seem to have any special method [for advising in the field]. You just let go [i.e., let the trainee make more decisions] one by one, let him do a little bit more [. . .] In the beginning, maybe I would tell him about how to do it. Then after the second time, I would tell him that you can check some relevant literature. How do others do it? What do you want to do? Or how do you think about designing a questionnaire? So, it's my own idea to let go a little bit more at a time [. . .] I take him to the scene. Then the questionnaires are completed and returned. Let him analyse, and then we discuss the results. After the second time, it may be that I tell him, 'This is happening now. First, find out if there are any relevant things and related documents. You tell me what you want to do. I can provide any information here for your reference.' Maybe the second or third time it will become like this. Then it may continue. . .but there is no way to completely say that—you [trainee] just do it.

Watching their faces—

NG (senior advisor): [We] have many different kinds of trainees. So, in the past couple of years, I'm a bit more careful [about assigning roles]. Their background and their [learning] needs—of each [trainee]—this is what I first would like to know [. . .] At the same time, the first day or second day of the investigation, I frequently watch the [trainee's] performance and their attitude towards [. . .] this event [. . .] So, in one or two days of the investigation—this is important for me—I watch their face and the attitude [. . .] their interest in the event or their performance in the event [. . .] And the one important thing—I think the most important—is their, not background, but attitude. Even though they do not have any experience [for this type of event], it is okay, but if they have some strong interest in the event, then they can catch up on everything.

So, what I value the most is their [. . .] attitude or interest in the investigation.

Some trainees described meeting program requirements as 'ticking the box.' For field investigations, the 'box' referred to completing an investigation report. Instead of increasing or shifting roles and responsibilities or seeking multiple opportunities for peripherality, some advisors prioritized ensuring trainee participation in an investigation fulfilled the requirement.

Just in case nothing comes up—

DY (second-year trainee): So, I mean, because I was so new, I didn't have as much of a leadership role as I probably would have if I—if it had been further in my journey, but I sat in on all the meetings and kind of, you know, helped out with the case interviews, follow-ups, and then did some data analysis and just wrote it into a paper [. . .] I didn't feel any pressure or stress or, you know, and I didn't even really know that was going to be my outbreak [report] until afterwards, and then [my advisors] convinced me to do it just in case nothing else suitable came up.

Hitting the requirement—

SV (second-year trainee): I was very fortunate to, to actually be able to go over to the [local public health office] and, uh, almost have a secondment arrangement. So, I was there when they had a potential outbreak, which, um, turned out to be a very contained outbreak. And it wasn't a, um, it wasn't in any way exciting, but it hit the [air quotes, smiling], it hit the requirements. [Laughs] So that's done for me. I don't need to join another one for the moment.

Chomping at the bit—

RC (first-year trainee): Um, and we've had a couple of mini outbreaks that wouldn't—or have been recommended to not be my [. . .] outbreak, but I've just been being involved in them, um, learning about different pathogens [. . .] Yeah, kind of like listening how the clinical team, like the nurses and the doctors approach giving advice to the [facilities], and just kind of understanding how they work as well [. . .] Um, but nothing where we've needed to [jump in] at this stage. And then there's a few other small ones that have happened, you know, [. . .] where a pathogen's been detected, but it's not meeting that threshold to like call it an outbreak [. . .] So, if there was one more case, there would be reason to

investigate, but, um, not at this stage. I'm chomping at the bit. I just want an outbreak.

Projects

Except for topic selection, trainees led their projects, reflecting this learning environment's lower risk compared to field investigations. Projects included analyses of surveillance or hospital data, assessments of health interventions, and evaluations of surveillance systems. With longer timelines than field investigations, trainees often worked within their workplaces, with minimal public engagement. Trainees regularly checked in with advisors for progress updates and input.

Advisors rarely described their approaches to topic selection, but trainees often noted that some topics were assigned while others were self-proposed. For example, one program allowed trainees to propose their first and third projects, while assigning the second. Across narratives, common topic selection criteria included workplace relevance, data accessibility, feasibility, and alignment with learning objectives. By focusing on these factors, advisors guided projects to approximate the practice of field epidemiology, ensuring peripherality, as illustrated in these two narratives:

Epidemiological research on their mind—

AY (second-year trainee): Everyone is free to present what kind of research they would like to do, first [. . .] Well, I guess [the advisors have] epidemiological research in their minds, but my ideas were not like epidemiological research. So, they proposed, 'Well, we have this idea for an epidemiological study. How about this?' which I had not thought of—that topic—at all, but since they kindly gave me the suggestion, I said, 'Okay, I'll work on that' [. . .] Then [. . .] I was given homework like, 'You probably don't know anything about this disease yet, so please do some research on it.' So, I checked it out, and when I said something like, 'This is what I found [from international papers, my advisor said] that [in this country] there is no information available, so maybe we can use that as a starting point.

Interested in the outcome—

SV (second-year trainee): I obviously have some sort of [face brightens] desire to contribute [to the workplace] and to feel like I'm able to produce some outputs [. . .] For my [project] I was working with a

different team because that's the team that was interested in the outcome. And they said, 'This could be a really interesting project for an [FETP trainee], and it will hit your [requirement].' And um, so sort of talking to that team, I said, 'What is the outcome you want to see? What is like the public health action, I guess, that will come out of this, the results of this project, the findings?' And that was a great way to frame what they needed [. . .] I narrowed down the scope to fit the, the purpose that the, the team were asking, like, um, the whole, the whole purpose behind the project.

In one program, trainees completed a group research project. Advisors assigned leaders and topics, requiring trainees to complete all aspects of the project, including the research proposal, protocol, data collection, analysis, interpretation, and presentation. Advisors and subject-matter experts supported the groups. This approach exemplifies peripherality by reducing 'production pressure' (Wenger, 1998, p. 100) through shared responsibility among trainees.

Routine placement work

For routine placement work, advisors typically assigned roles across the cohort, gradually increasing responsibility over time. This learning environment had lower risk and intensity than field investigations. Trainees performed simpler tasks in cohorts or groups, often involving only internal stakeholders. When external stakeholders were involved, advisors vetted or accompanied trainees, as seen in the example from 'SD:'

Listening on the side—

SD (first-year trainee): Well, I made an inquiry to the [local health department] to confirm the status of the outbreak [. . .] I am still inexperienced, so I consulted with the [advisor] to find out if there was anything missing or points to consider when making inquiries, etc. [. . .] In the end, she decided to attend the call with me, and she listened to the call on the side as I was listening to the [counterparts] on the phone, and if there was anything missing in what I supposed to ask, she would teach it—the additional thing—to me by writing on a paper.

Similarly, for 'FA,' the timing and extent of increased responsibility depended on workplace demands, such as covering for absent staff, and on the trainee's readiness:

After that it was my turn—

FA (first-year trainee): I've been learning, I guess, the like day-to-day business-as-usual activity of an epi, so doing like the weekly like communicable diseases surveillance report, like preparing that and presenting it. And so now we do a roster, and we take turns of doing that [. . .]

So, before there was only one epi because [. . .] the other one was sick. So, she was doing it every week. Um, and so I guess firstly I just sat in [. . .] and then she was like, 'Okay, you're going to be doing this' [chuckles]. And so, then I went to her office, and I watched her do it. Um, and then after that it was my turn.

In one programme, routine placement work for first-year trainees included daily monitoring of surveillance reports and media for potential public health events. Advisors assigned areas and diseases to trainees and rotated leadership roles among trainees for daily meetings. After completing the introductory course, second-year trainees guided first-year trainees and handed over their duties to them. Each morning, trainees presented monitoring outcomes, including risk assessments, at an internal FETP meeting. Advisors questioned trainees on their reasoning and logic, providing input that sometimes led to disputes among advisors about the appropriate follow-up actions. As a group, trainees and advisors determined follow-up actions and decided what to report at the next daily meeting, attended by FETP leaders and external stakeholders (e.g., the surveillance or vaccine-preventable diseases divisions), who further questioned and provided input.

By assigning these roles and responsibilities, advisors opened the practice to first-year trainees through peripherality. Trainees engaged the dimensions of practice: mutual engagement with advisors and other field epidemiology practitioners; a shared enterprise focused on identifying health threats, assessing risk, and determining action; and a shared repertoire of tools and histories, like surveillance reports, reporting forms, risk assessment templates, and stories from past events. Advisors managed peripherality with close supervision, special assistance from second-year trainees, and shared responsibility and nested decision-making to reduce the cost of errors. This daily engagement allowed trainees to develop a sense of how the field epidemiology COP operates.

Laying groundwork to bestow legitimacy

Another dimension of advisor stewardship was 'laying groundwork' to help trainees fulfil their roles and responsibilities. Completing projects, field investigations, and routine placement work required access to data, experienced field epidemiologists, and subject matter experts outside field epidemiology. While FETP trainees had some legitimacy due to their roles, many narratives underscored the need for advisors to connect them with people, systems, and data. By laying this groundwork, advisors bestowed additional legitimacy to trainees.

> **Everything has contributed—**
>
> *ZT (second-year trainee): My [advisor] is a great [advisor], and he passionately provided guidance so that I could conduct [my project], the kind of research I wanted to do, and also coordinated with related institutions when necessary [. . .] Everything, everything that he suggested has [contributed to] the research [. . .] One is that he laid the groundwork in advance for the research with [stakeholders] involved. He communicated to them, 'This is the kind of research [the trainee] wants to do, so please help us out,' and that was the first step.*

> **Having a good connection—**
>
> *LI (second-year trainee): So, I asked my [advisor], like, do you have any relationships with [this hospital]? Can you [. . .] ask for like collaboration to try to find out what happened with this [cluster]? And luckily, [my advisor] has a good connection with the leader at the centre of [the hospital]. So, they [. . .] have some phone calls, and he said, 'Oh, they [. . .] don't know the source of the disease [. . .] If we join with them, we can like describe the epi [. . .]. We can find some hypotheses about the source [. . .] So, they really need the support from epi side because they are just clinical [. . .] So, they don't know [. . .] what is the epidemiology now of this disease. So, they are happy to collaborate with [us].*

Adapting modes of engagement

The third dimension of advisor stewardship involved interacting with trainees to facilitate learning. Acting as members of the COP, advisors negotiated the meaning of the practice with newcomers and supported their development of competence. Advisors varied their engagement, ranging from hands-off to hands-on (see **Figure 6.1**). We outline six modes of engagement along this spectrum and explore how culture and context influence the mode advisors employed.

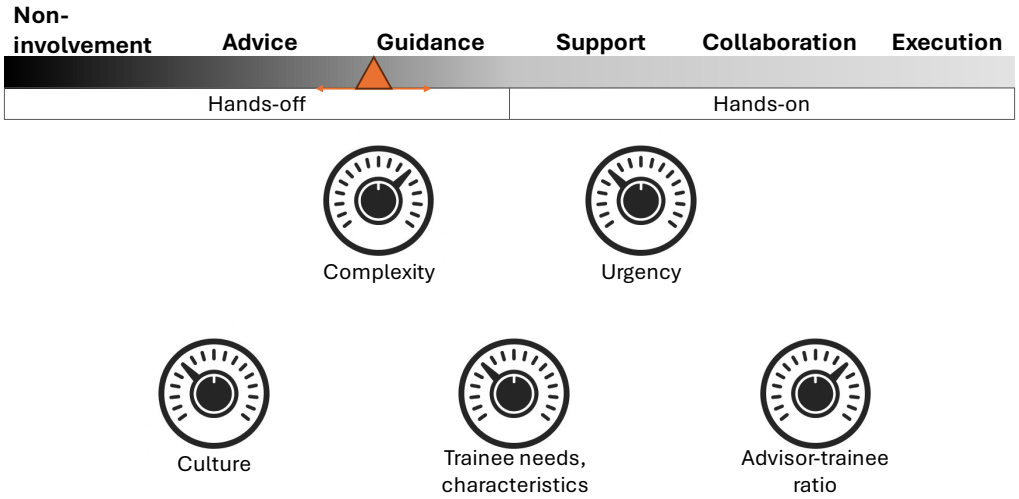

Figure 6.1. FETP advisor-to-trainee modes of engagement spectrum with factors (dials) that move the interaction (orange triangle) towards hands-off or hands-on engagement.

Non-involvement

Some narratives described advisors being uninvolved with a trainee for a given task. These accounts, from trainee interviews across all programs, included situations where trainees acted independently, were sent to complete a task without advisor involvement, or when the advisor was unavailable. For example, a first-year trainee independently developed a disease dictionary after recognizing a gap in her infectious disease knowledge during surveillance meetings. Most trainees sent without advisor involvement were in their second year. For instance, second-year trainee 'EC' took over an ongoing investigation from a colleague just before a briefing among subject-matter experts. EC attended without an advisor, learning through observation and reflection:

> **Learning through reflection—**
>
> *EC (second-year trainee): [M]aybe it was my first time to attend a meeting like this. So, I wasn't quite sure about the role of a [field epidemiologist]. My original thought was, I would talk about it when I was asked a question, or I would find an opportunity to talk about epidemics and infectious diseases at another time [. . .] Then my own reflection is that what I did was not enough. Before that meeting, I should have clearly listed the agenda and the items to be discussed. Preparation before the meeting is sometimes more important than during the meeting [. . .]*

Most non-involvement interactions resulted in positive learning experiences and highlighted trainee tenacity, particularly resourcefulness and perseverance. Trainees relied on alternative learning resources, such as textbooks, peers, colleagues, literature, or experts to navigate these situations. A few narratives expressed negative sentiments, including anxiety, disappointment, and demotivation. Some attributed advisor non-involvement to human resource limitations or a low advisor-to-trainee ratio.

Advice

Many narratives described advisors providing advice to trainees on specific tasks. In these interactions, trainees sought input or asked questions (see 'LI' below), and advisors offered suggestions while leaving the decision to the trainees. These interactions were typically brief and one-time occurrences. Most accounts came from trainee interviews, with a few from advisor interviews and participant observations. A majority involved non-FETP staff, such as statisticians, subject-matter experts, or workplace advisors. For example, when first-year trainee 'AM' was unsure about which statistical test to use for a project, she consulted a statistician who recommended a test. In another example, multiple trainees attended a meeting with workplace advisor 'TH' as part of their routine placement work. After trainees presented cases under monitoring, TH clarified the meaning of the cases, emphasized vigilance and follow-up, encouraged more discussion in the future, and concluded the meeting.

> **You must ask questions—**
>
> *LI (second-year trainee): [My advisor is] very good [. . .], but just only you [must] ask questions, and if you have the request for [him], [he] will [help]. But if you don't like ask [him] or something like that, [he] will assume that you are still working on your project—no problems, no challenges—and I think, yeah, it's, it's understandable*.

Most advice interactions elicited neutral or positive sentiments, though a few trainees expressed a desire for more engagement. For instance, first-year trainee 'TE' described receiving advice on an outbreak investigation but wished for specific direction:

Wishing for a detailed map—

TE (first-year trainee): When we go to the outbreak, [our advisors] provide information and [advice]. We know the general things, like going to the field and assessing the situation first [. . .] but [. . .] we need detailed structured mapping, like when do we need to [use] a questionnaire first? Or do we need to meet with the organization's director first? Or do we need to conduct situation analysis, like see [the restaurant's] kitchen?

Guidance

Some narratives described advisors providing guidance on a given task, offering direction on how to implement a suggested approach. Trainees could choose whether to follow the guidance or take a different path. Most of these accounts came from trainees, with one from participant observation. Advisors in these interactions included FETP staff, field or workplace advisors, and one non-FETP expert. Guidance occurred across various contexts, including projects, outbreak investigations, routine work, and conference presentations, through verbal, written, or physical means (i.e., demonstration).

Seeking a way forward—

DY (second-year trainee): I'm meeting with [my advisors regularly. . .], and I order my questions [first with], I guess, the things I'm not leaving this meeting until I get an answer for this or a way forward with this or direction on this [. . .] I will just grill them on their comments [on my draft], and we'll just, for each thing, reach a consensus, and then I'll go away and do the thing.

Guidance interactions did not elicit negative sentiments nor a desire for greater engagement. These interactions ranged from reactive—where trainees sought guidance on specific questions or outputs, as in DY's case—to proactive, where advisors initiated plans or directions. For instance, a workplace advisor provided second-year trainee 'ZM' with a plan for conducting a surveillance evaluation. ZM wrote a proposal, received feedback, and an FETP staff advisor introduced ideas for incorporating qualitative research with semi-structured interviews, a method unfamiliar to ZM. The advisor

helped narrow the list of potential interviewees, which ZM found helpful. In another example, LI described preparing an abstract for a conference:

> **Reorganizing the sentences—**
>
> *LI (second-year trainee): My [advisor] helped me to reorganize the [. . .] order of the sentences [. . .] especially for the background part because he said, 'If you want to describe an outbreak, you should start with like, uh, what time the outbreak started in what affected [locations], who is the population at risk, something like that. So, you should write like this. And then I learned the structure of writing the background from him. And then I revised the, the abstract.*

Support

Some narratives described advisors supporting trainees for a given task. While trainees completed the work, advisors were present and responsive, particularly during troubling times. Advisors often provided clear examples or demonstrated parts of the task to reveal behind-the-scenes knowledge. Support went beyond correcting a task or providing recommendations: advisors stepped in to offer help, emotional support, or another chance, momentarily meeting trainees at their level.

Most of these narratives came from trainees, with a few from advisors. Advisors were primarily FETP staff, with a few workplace advisors and no non-FETP experts. Support occurred in routine work, projects, field investigations, and conference presentations. In some cases, trainees requested support; in others, advisors identified and addressed the need. For example, trainer 'DW' supported first-year trainees to assess the risk of an international event by showing them processes, demonstrating structures, and completing parts of the task without providing direct answers. DW gave examples, answered questions, and directed trainees to relevant resources, leaving the task finally up to them. Advisor 'WS' summarized this 'support' approach as helping trainees to see that mistakes are human.

> **Human work means making mistakes—**
>
> *WS (senior advisor): I understand that [an advisor] is a person who has gone through suffering. Trainees come to me [. . .] and everyone's problem is not understanding what results to expect [. . .] [An advisor] is the one who will explain the point that [the trainee] is stuck on or [help*

the trainee] to understand [that] human work [means making mistakes]. Besides, [the advisor] is not trying to perfect [the trainee's work]. If I can explain closely the concept that I have solved at the point where the trainee is stuck, then I understand that [I am] doing it.

Second-year trainee 'ZT' exemplified this sentiment, recalling a moment of frustration and despair when upper management halted the publishing of her analysis.

What saved me—

ZT (second-year trainee): When we heard 'We can't release it,' the [advisor] was also upset together [with me] and said, 'What the heck was the point of making [the report]?' That saved me. But I was so frustrated that I felt down for about a day and reflected a lot like, why am I doing this? But after a day passed, I realized that although I was still frustrated, I had to keep going. I switched to a more positive frame of mind and thought, 'If I keep at it, maybe this will see the light of day.' But what saved me the most was that the [advisor] was feeling the same way.

Collaboration

A few narratives depicted advisors collaborating with trainees for a given task. In these examples, advisors and trainees shared responsibility, or the trainee had ultimate responsibility, but collaboration arose through sustained interactions where neither party knew the answer, or they lacked sufficient time for more engagement.

These accounts came from participant observation, advisors, and a trainee, with all advisors being FETP staff. Collaboration occurred during projects, routine monitoring, and outbreak investigations. For example, junior advisor 'DW' identified trainees' misunderstandings about a routine work role and realized that advisors were also unclear. This led to collaboration to clarify the role and build the system:

Collaborating on routine work—

DW (junior advisor): The reaction that I felt from the [trainees] was that we're sharing the challenges, I think. They understood this is not a completed [system]. So, I kind of felt the sympathy from them to me, I think. I also thought like they really understood the importance of what we are doing [. . .] I still feel like [the trainees have] really like collaborative attitudes, like we are really making the new system right now.

In another example, junior advisor ‘YS’ collaborated with first-year trainee ‘NC’ to define a project:

> **Inquiring together—**
>
> *Participant observation*: *[YS] is [. . .] saying the potential outcome, saying maybe to compare skills, saying that we have to make the difference before introducing the unique intervention because otherwise there is no meaning, but it doesn't mean that there will be no difference when you give the [intervention]. ‘Of course, there is a difference, but what is the expectation of the [intervention]?’ ‘[I see],’ says NC, his fingers rubbing his eyes [. . . YS] says to evaluate cases, not attack rates. Then [YS] apologises for making so many suggestions and admits that he is not sure of the best way to do it. It seems [as though] he is thinking it aloud with a colleague, trying to come to the solution together.*

Senior advisor ‘NG’ described a major shift in one trainee’s mindset, evolving from asking superficial questions to addressing core issues in an outbreak. A moment of collaboration during an overwhelming investigation catalysed this shift:

> **One-by-one, we checked together—**
>
> *NG (senior advisor): I asked [that trainee] to check the patient charts, but he was not accustomed to patient charts, and it was one-by-one, we checked together [. . .] It was a really hard time, I think, for him. It was also hard for me—for me as well! And that kind of outbreak investigation and, really, on-the-job training made him change his mindset.*

Execution

A few narratives described advisors executing a given task either for the trainee or while the trainee observed. These interactions typically involved more senior individuals taking over because the trainee was unprepared or perceived to be so.

Trainee accounts described interactions with FETP staff and workplace advisors, primarily during outbreak investigations and occasionally in routine placement work. For instance, two trainees separately recounted joining ongoing outbreak investigations where they attended meetings without a defined role. They observed their advisors moderating discussions, building connections, maintaining impartiality, and laying groundwork for decision-making. Both noted that attending these meetings provided

invaluable learning experiences they would not have gained otherwise. Unlike EC's *non-involvement* interaction, where the trainee participated without the advisor, interactions here involved advisors executing tasks while trainees observed.

In another example, during a large outbreak that overwhelmed the response system, a workplace advisor asked a first-year trainee, 'PP,' to answer public and media inquiries. Feeling unprepared, PP signalled for help, prompting a senior colleague to read relevant health education materials aloud while PP hid on the side making phone calls. 'After a few times, I learned how to give this advice and how to do these actions' (PP, second-year trainee).

Employing the modes of engagement

Most advisors preferred trainees to complete tasks independently (i.e., Non-involvement), viewing this approach as more effective for developing field epidemiologists. They adjusted their modes of engagement, however, based on cultural and situational influences.

While we did not formally analyse culture, program-specific tendencies suggested cultural differences, supported by several narratives. For instance, trainees in some programs expected more Advice, while others expected Guidance. DY's description of 'grilling' advisors (see Guidance) might not be well received by advisors in other programs. Similarly, first-year trainee 'CC' hesitated to ask follow-up questions, perceiving advisors as embodying 'the same attitude as the teachers of the old [traditions] that constantly give commands.' When asked if he had tried to clarify his confusion with his advisors, CC responded,

> *No, I did not. I told you: because there are [advisors] like the teachers of the last generation [. . .] They generally treat such problems in a very [aloof] manner. The [advisors] might say, 'We taught these lessons already' or something like that. So, there is no need to ask additional questions.*

In contrast to arguing, RA, an advisor from another program, characterised the trainees there as accepting hierarchy.:

> **Where trainees do not argue—**

RA (senior advisor): I tend to let [the trainee] decide. I'll give him some advice and see how it goes. About once or so—once or twice, not too much. I prefer the idea of supporting [trainees . . .] Most of [the interactions] went smoothly like this, but the [memorable] ones were influenced by outside ideas. For example, our [supervisor] would say, 'It's not right for you to do this. You should do that.' Then [. . .] I will tell [the trainee] directly, 'Everyone has different opinions'. Right.

Interviewer: How would the [trainees] respond?

RA: Seems to be okay. Nothing special, because [in this country] or in [the broader regional] culture—less like [other cultures where] people would argue with others or something—everyone is very accepting of this kind of. . .—or maybe because we all come from the medical field, and you know the medical field, that is, [rank]: what the professor says counts [. . .] So, most people will be more obedient to the [rank]. [They are] less likely to go to argue [. . .]

Interviewer: [. . .] Are there any [trainees] trying to argue?

RA: Not in my memory.

Situational factors also influenced advisors' modes of engagement, including trainee characteristics and learning needs, task urgency and complexity, and advisor-to-trainee ratios. For example, RA and NG described adapting their approaches during field investigations (see Field investigations) by assessing trainees and gradually increasing responsibilities. Most trainees reported receiving the level of engagement they felt they needed. When they did not, however, they either demonstrated tenacity by seeking alternate learning resources or struggled, expressing anxiety, disappointment, or demotivation.

While greater situational complexity shifted engagement towards the hands-on approaches, greater urgency shifted them away from Support and Collaboration toward Guidance, Advice, or Execution. For example, junior advisor 'DW' noted that urgency pushed her toward an Advice approach:

Skip the repeat questioning—

DW (junior advisor): So, if I'm really in a hurry—I mean like we're in a real hurry, I sometimes have to skip the repeat questioning to [the trainees]. So, I just have to directly show my thinking process and [see] whether they agree with this process, and that's—yeah, and I don't think I have any experience [where] they refused my proposal yet [laughs]. So, that's how I manage my time, I think.

In another example, senior advisor NG divided field investigation presentation roles among the team, except for the recommendations: 'This part is a bit tough for them and for us. So, we make together' (NG, senior advisor). NG also emphasized the need to balance trainee characteristics and needs with situational urgency:

> **Balancing patience and event urgency—**
>
> *NG (senior advisor): For example, making the epi curve, we frequently tell [trainees] how to make them [. . .] Some are good, but some are not so good. So, we need to wait until they understand which part [of the graph] is important [. . .] This kind of discussion, we are almost all the time doing and waiting until they understand. It takes time. But in the field, this kind of time-consuming training is a bit—the [advisors] need to manage that [. . .] Sometimes the training is [more] important than the event management. In that case, we take more time for this kind of training. But in some cases, the result [of the investigation] is more important than the training [. . .] So sometimes [. . .] we cut off the time of the training and make the results by [. . .] ourselves.*

Advisor-to-trainee ratios also influenced modes of engagement. This influence was most evident when comparing the program with the lowest ratio to the one with the highest. In the former, where Non-involvement and Advice were more common, trainees often reported insufficient access to advisors. In contrast, trainees in the latter, where Guidance and Support were prevalent, trainees described consulting multiple advisors based on their specific needs.

Discussion

This study examined FETP advisor stewardship in four countries through the lens of Lave and Wenger's situated learning in COP, identifying three dimensions: managing peripherality through role and responsibility assignment, bestowing legitimacy through laying groundwork, and interacting with trainees via adaptive modes of engagement. These findings offer novel insights into a critical element of the FETP learning process, extend Lave and Wenger's work on legitimate peripheral participation, and could inform the design and evaluation of FETP and health workforce development programs.

Our analysis introduced a novel spectrum of FETP advisor modes of engagement, providing a framework for understanding how advisors adapt their interactions to meet

trainees' developmental needs and situational demands. While no such spectrum has been published for FETP, research in other fields similarly highlights the fluidity and adaptability of mentoring and supervision. For instance, Radha Krishna and colleagues (2019) identified a spectrum of educational approaches in internal medicine residencies—role modelling, teaching, coaching, and supervising—that vary based on learner motivation, learning relationships, learning environments, and assessment types. Similarly, Hu and colleagues (2019) identified three medical educator positions—Diagnostician, Judge, and Confidant—emphasizing the dynamic nature of mentoring interactions that consider whether the students are positioned as 'good' or 'troubling'. Obara and colleagues (2021) found power distance, collectivism, uncertainty avoidance, and masculinity to be key cultural characteristics influencing mentoring relationships among Japanese physician-scientists. Our spectrum adds to this body of knowledge by defining six modes of engagement that reflect not only cultural influences but also long-term situational factors (e.g., advisor-to-trainee ratio, trainee characteristics) and immediate considerations (e.g., situation complexity, urgency, and learning needs).

The spectrum provides practical guidance for advisors and programs to support learning. For example, it suggests a general trajectory from hands-on to hands-off engagement as trainees progress, aligning with Vygotsky's (1978) Zone of Proximal Development and inversely with Lave and Wenger's (1991) centripetal movement from periphery to community membership. Cultural expectations and task characteristics, however, may trigger deviations from this trajectory. By recognizing these influences, advisors can tailor their engagement to maximize learning. Programs can therefore train advisors to apply this spectrum, ensuring that cultural expectations and situational demands are addressed. Specifically, advisors should be able to 1) understand how local cultural expectations shift the starting point; 2) reflect on their own ability to employ each mode and intentionally strengthen their weaker modes; 3) explain the spectrum to trainees early in FETP so they know what to expect and how to request appropriate engagement; and 4) apply the general tendency of hands-on to hands-off engagement while identifying factors that shift the mode as the circumstances dictate.

In addition to the spectrum, this study deepens understanding of FETP learning by emphasizing FETPs as the periphery of the field epidemiology COP and advisors as

stewards. Advisors in this study served as periphery stewards, facilitating access to the COP by managing peripherality and bestowing legitimacy. Lave and Wenger (1991) underscore the importance of access to the COP, but they do not explicitly identify a role to ensure this access. 'The issue [of access] is so central to membership in communities of practice that, in a sense, all that we have said [in the preceding 100 pages] is about access' (Lave & Wenger, 1991, p. 101). Across the four case studies in their seminal work, they note that the role 'depends on the characteristics of the division of labour in the social milieu in which the community of practice is located' (p. 92). In Wenger's (1998) study of claims processors, he suggests that the problem of access lie with not having a recognized role to facilitate it:

> [Newcomers] have to get enough attention and create enough relationships with busy old-timers to gain access to the community and its practice [. . .] Old-timers do spend energy introducing these newcomers into the actual practice of their community, but there is little official recognition for their efforts and they are under their own production pressures (p.100).

Wenger suggests an effective approach would be to recognize and encourage the 'busy old-timers' and facilitate the process. Similarly, James and Lokhtina's (2018) case studies of two academics at the periphery of their new institutions struggling to become members concluded that they lacked mentors to shepherd them through the process.

In FETPs, advisors fill this critical gap by deliberately opening the practice of field epidemiology to trainees through peripherality and legitimacy. We therefore extend Lave and Wenger's work by illustrating how a specific role stewards newcomers through the difficult periphery. Advisors in our study did this with various strategies: in field investigations by gradually increasing trainee autonomy, assigning responsibilities based on field assessments, and ensuring focus on minimum requirements; for projects by selecting topics that aligned workplace relevance, data accessibility, feasibility, and learning objectives; in routine work by employing close supervision, shared responsibility, special assistance, and nested decision-making. By connecting trainees with people, systems, and data, advisors bestowed legitimacy and laid groundwork to facilitate the learning opportunities necessary for trainees to build competence.

The dual roles of FETP advisors—as builders of competence and stewards of periphery—were essential to the learning process. These roles align with activities

identified through prior research, such as teaching techniques, providing feedback, ensuring outbreak exposure and appropriate responsibility, and helping negotiate organizational issues and develop networks (Forbes et al., 2019). They also build on the mentoring frameworks described in healthcare settings (Burgess et al., 2018; Radha Krishna et al., 2019). Without these advisors' roles, trainees would struggle to access the resources, relationships, and responsibilities necessary for learning. Although trainees may build tenacity when advisor engagement is limited, whether the trainee is heading in the right direction remains a risk. For that reason, Langmuir implemented checks and balances through mentoring and supervision in the first FETP (Schaffner & LaForce, 1996). On the other hand, expert review by a non-FETP advisor could mitigate the risk, but the trainee would then need someone to facilitate access to the COP. The criticality of FETP advisors brings to question their availability, especially in resource-limited contexts. Though not analysed in this study, an apparent relationship between advisor-to-trainee ratios and the country's wealth suggests that access to the COP and thus to learning opportunities is more difficult in countries with limited access to resources.

Although advisors may be a critical element of FETP learning, they are not the only one. Trainees learn through interactions with individuals outside field epidemiology as well, such as statisticians, laboratory professionals, environmental health officers, and the public (see Chapter 5). While important, however, those interactions do not focus on opening the practice. Also, though we have focused on advisor stewardship, most learning in FETP is self-led (see Chapter 5). Trainees carry out their projects largely alone. They work in teams but complete many workplace assignments and field investigation roles alone. When they recognize gaps in knowledge, trainees leverage learning resources to fill them. Advisors play this critical role within a system that engages trainees in public health contexts, one facilitated by trainee tenacity and learning environments, as well as advisor stewardship. Nevertheless, without this key advisor role of stewarding the periphery, most trainees would not have access to the practice nor its learning opportunities.

This study of four FETP in the Asia-Pacific cannot represent the diversity of one hundred programs across the globe. Specifically, the study did not include any programs from least developed countries, nor did it include any 3-month FETP Frontline

programs. Furthermore, we were unable to interview advisors of Australia's program, the only university-based program in the study. We advise caution and contextualization when attempting to apply the findings beyond the study programs. Nevertheless, the findings here are the first in the published literature to explain how FETP advisors steward learning.

Our findings highlight several actionable steps for FETP, as well as considerations for the broader health workforce development field. We urge focus on investments and assessments targeted at advisors' capacities to build trainee competence through adaptive modes of engagement and to serve as periphery stewards by managing peripherality and bestowing legitimacy. Assessment and training tools would support these efforts. Jones and colleagues' (2014) evaluation of the frequency and method of contact proves valuable with this new understanding; yet, we must aim to further understand how contact advances peripherality and legitimacy and how advisors adapt contact to circumstance. Research into the applicability of the modes of engagement spectrum and the approaches used in FETP beyond those in this study would support such efforts. Programs and partners should also prioritize achieving advisor-to-trainee ratios that ensure appropriate modes of engagement for each program's trainees, especially in countries with limited access to resources. Importantly, we do not recommend establishing a COP to facilitate learning. Although that approach has often been used in the health professional education literature, it contradicts Lave and Wenger's intent for COP to serve as an explanatory learning framework (O'Brien Bridget & Battista, 2020). Indeed, COPs exist wherever a group of people engage in a common enterprise, have opportunities for mutual engagement, and share a repertoire of tools to make meaning of their enterprise. Intervention should thus focus on supporting them.

Conclusions

This study provides the first published analysis of FETP advisor stewardship, introducing a novel spectrum of engagement modes and illustrating the dual roles of advisors as competence builders and periphery stewards. Advisors are essential to FETP learning, facilitating access to the COP and shaping trainees' development.

Programs must invest in advisor training, ensure adequate advisor-to-trainee ratios, and develop tools to monitor and enhance advisor interactions. By addressing these areas, FETPs can strengthen their capacity to prepare dynamic field epidemiologists capable of facing the coming public health challenges.

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Chapter 7 Discussion

Does everyone have similar problems [developing trainees]?...I don't know...I believe that by your research, everyone is more willing to talk about their own problems, and then after you put it together, maybe you can...let everyone know what kind of problems everyone is facing and what should be the solution, or we can learn from others. I'm actually looking forward to seeing the results.

—senior FETP advisor, Taiwan

Through this thesis, I aimed to contribute meaningful knowledge of FETP learning to the FETP and public health workforce development communities. To do so, I conducted a case study examining the approaches to learning within the foundational FETP and how they contributed to FETP's longevity and dissemination. I also located FETP epistemologically and provided direction to contemporary FETP practices. Additionally, I conducted a qualitative study exploring learning processes within contemporary FETPs, focusing on strategies for training and learning and examining the alignment of principles and practices across four programs.

The case study analysis situated the foundational FETP (U.S. EIS) within a constructivist, humanist-situated learning framework—an unexpected finding given the context (see Chapter 3). This epistemological orientation suggests that FETP embraces constructed truths rather than objective, discoverable Truth. I argued that the flexibility and adaptability inherent in this orientation facilitated the program's endurance and dissemination. The analysis revealed intentional training devices extending beyond lectures, case studies, and assignments. It uncovered a process that emphasizes

facilitating learning rather than delivering content and underscored the importance of learning from practice and experience. Viewing these findings through Lave and Wenger's (1991) framework demonstrated how the foundational FETP managed the risk of error on population health while constructing field epidemiologists' knowledge, tacit understanding, and practical capabilities for dynamic contexts.

The qualitative study identified a common learning process across four FETPs, in which trainees learn through engagement with and within public health contexts. I also identified three key facilitators of this learning process: learning environments, trainee tenacity, and advisor stewardship (see Chapter 5). The learning environments of field investigations, projects, and routine placement work provided meaningful contexts and purposes for trainees to engage, offering valuable learning opportunities. As trainees interacted with people, data, systems, and knowledge within these environments, they reinforced, revised, or revealed gaps in their knowledge. They bridged these gaps with self-led learning strategies. In contrast, the intensive course learning environment demonstrated less robust learning, likely due to trainees' sequestration from the practice. According to Lave and Wenger (1991), such sequestration complicates the ability to grasp the meaning, knowledge, and competence of the practice, emphasizing the importance of peripherality and legitimacy in opening the practice to trainees. This finding aligns with the case study, which showed that the foundational FETP prioritized practice-based learning over didactic approaches. Trainee tenacity, encompassing motivation, perseverance, and resourcefulness, was a critical facilitator, enabling trainees to remain engaged despite challenges and thus creating more learning opportunities.

A deeper exploration of advisor stewardship, the third learning process facilitator, revealed three dimensions: managing peripherality, bestowing legitimacy, and engaging trainees through adapted modes of engagement to build their competence (see Chapter 6). Drawing on Lave and Wenger's work (1991; 1998), I illustrated the critical role of periphery stewards to the process of legitimate peripheral participation in COPs, a role that advisors fulfill in FETP. Advisors adjusted strategies for managing peripherality based on the learning environment, aiming to balance trainee exposure to the practice, trainee responsibility and risk, and broader contextual pressures. To bestow legitimacy, advisors laid the groundwork for trainees by connecting them with

the people, systems, and data required to complete their tasks. Finally, to explain how advisors engaged trainees, I presented a novel spectrum of six modes of engagement (Non-involvement, Advice, Guidance, Support, Collaboration, Execution) and demonstrated how culture and situational factors influenced these modes. By portraying advisors as stewards of the periphery, I reconceptualized FETP *as* the periphery of the field epidemiology COP and extended Lave and Wenger's work by illustrating how, within FETP at least, one stewards the COP periphery.

Together, these findings describe historical and contemporary training approaches and learning processes in FETP, providing explanations for FETP's endurance, dissemination, and contributions to public health workforce development. They also identify practical tools (e.g., the spectrum of engagement) and leverage points (e.g., the learning process facilitators) for evaluating, planning, and enhancing learning in FETP and the broader public health workforce communities. The findings highlight an alignment between the FETP principle of 'learning by doing' and the processes that engage trainees in public health contexts where meaningful learning opportunities emerge.

Additionally, the findings reveal a misalignment between the FETP community's focus on curricula and the research finding that most learning occurs in practice rather than formal courses. Curricula design with competencies, instructional goals, and learning objectives, like those presented in WHO's Competencies for One Health field epidemiology and CDC's standard curricula (*Guidance for One Health field epidemiology curriculum development: a supplemental manual to the Competencies for One Health field epidemiology (COHFE) framework*, 2023; Traicoff et al., 2008) imply teaching, instruction, targeted intervention to reach a defined learning objective. Yet, in this study facilitators of learning were related to learning environments, trainee tenacity, and advisor stewardship, not curricula design. Given that the foundational FETP embraced a constructivist, humanist-situated learning approach, it raises the question of whether a shift has occurred toward an educational worldview that favours content delivery, competency assessment, or cognitive information processing. Before continuing, however, I will clarify how the methods and theoretical framework may have influenced these findings.

The contribution of and to the critical reference group

I engaged the lead trainers of the participating programs because I value participatory research. Participatory research is both more ethical and more likely to yield relevant outcomes than non-participatory research methods. As outlined in Chapter 3, Wadsworth (1998) highlights the value of participatory research and CRGs, emphasizing their role in co-constructing knowledge rather than positioning the researcher as an external expert.

Implementation of the CRG, however, was not straightforward. According to Wadsworth, my role as an outsider should not be 'operating as the independent expert determiner of the truth-of-the-situation… [but rather] a facilitator of or an assistant to the critical reference group's own pursuit of their truth (or truths)' (1998, p. 8). Although I hoped to collaboratively design the research, I entered the PhD with an impetus to study trainee learning. CRG members came with their own diverse needs and interests (see Figure 7.1), which diverged from my research direction. As a result, I advocated for a study of learning, and from there, we collaboratively designed and implemented the study and interpreted the findings. This process deviated from Wadsworth's ideal of co-generating the research, as being a PhD, the initial impetus and conceptual framework originated from me rather than the CRG itself.

Moreover, during collaborative aspects of the research, CRG members often faced competing priorities. To accommodate this, I varied my approaches: I brought data to meetings for collective interpretation, sent data in advance for individual feedback, and adjusted the length and frequency of meetings to suit CRG members' availability. While feedback on the process was positive, full participation remained inconsistent, particularly among members from government institutions.

Reflecting on these challenges raises concerns about the nature of our approach. Carr and Kemmis (1986) might categorize it as *technical* action research due to its externally formulated questions, or as *practical* action research because of the cooperative relationships with practitioners. In either case, the approach fell short of Wadsworth's vision of participatory research, where practitioners maintain a collaborative and self-reflective control over their practice. *Practical* action research, as defined by Carr and Kemmis (1986, p. 203), involves helping practitioners plan

strategic action for change, monitor the impacts of change, and reflect on the changes achieved—none of which were core components of our collaborative process.

Figure 7.1 Initial research interests among CRG members.

- **What skills do trainees need?**
- **Do the skills we provide help trainees in doing their job?**
- **How can we prioritise skills?**
- **Can we develop a logic model for the program so the government and other potential employers understand what the program provides the trainees?**
- **Can we document clear learning outcomes?**
- **Can we understand the skills employers want from graduates?**
- **Can we engage with key stakeholders to develop a shared understanding of expectations?**
- **Can we review programs, reflecting on their relevance for the future?**
- **Can we develop evidence of the broader program functions, beyond training delivery?**
- **Can we develop evidence that the learning experience is leading to skill development?**
- **Can we develop evidence of skill attainment, from trainees' outputs, formative assessments, exams, capstone projects, HR components (internship on graduation - feedback from supervisors)?**
- **Can we define the learning outcome or output that clarifies what a field epidemiologist is?**

Despite these limitations, the CRG shaped the research findings in important ways. First, discussing research ideas with the CRG helped to clarify methodological limitations, address potential concerns, and assess feasibility, strengthening the overall research design. Second, CRG involvement appeared to increase study participation. For instance, when trainee participation lagged in one program, the CRG

member proactively encouraged trainees to participate, resulting in increased involvement.

Third, CRG members provided analytical direction. During one meeting, for example, I presented a coding tree, and the members emphasized their interest in examining the intensive courses due to their substantial investment in course design and delivery. This input guided my analysis towards exploring diverse learning contexts, thereby revealing the learning environments. Such analytical direction not only mitigated the influence of my perspective but ensured that findings remained relevant to the FETP community.

Finally, CRG members lent credibility to the findings and interpretations. By sharing data, findings, and interpretations with CRG members who had both research and practical experience in FETP, I reduced the potential for researcher bias and increased my confidence in the conclusions. Doing so also identified areas warranting further analysis, helping to strengthen the credibility and verisimilitude of the research.

In summary, while the research problem did not originate from the CRG and the collaboration did not fully align with participatory ideals, the group's involvement substantially enhanced the methodology, increased participation, shaped analytical directions, and strengthened the credibility of the findings. These contributions underscore the importance of practitioner involvement in applied research, even when the collaborative process diverges from theoretical aspirations.

Additionally, while the CRG members shaped the collaborative process, the process impacted the members as well. Bringing program narratives to the members served as a mirror, allowing them to re-examine and re-perceive their programmes. At least one of the members noted that she was implementing changes to her programme based on the findings. Others appreciated how the findings articulated their intuitions and experiences. These comments suggest that participation in the research facilitated shifts in the CRG members' understanding of learning within FETP.

Such changes are in line with participatory research theory. Wadsworth, in describing a CRG as 'the researched for' (1998, p. 6), explains that they are those who 'have problematised a situation [and] are in the most strategic position to work on its improvement' (1998, p. 8). Carr and Kemmis similarly highlight this phenomenon as central to participatory action research, stating:

> While practical experience can be gained through unsystematic reflection on action, a rational understanding of practice can only be gained through systematic reflection on action by the actor involved…In short, action research is a deliberate process for emancipating practitioners from the often unseen constraints of assumptions, habit, precedent, coercion and ideology. Of course any particular project only achieves these results in a very partial and limited way; to imagine that it could be otherwise is to seek a scientific vantage point beyond the reach of history and human interests (Carr & Kemmis, 1986, pp. 189-192).

Although I did not intentionally facilitate the CRG members' self-reflection or planning for change, nor did I systematically assess the impact of the research on them, their participation nonetheless appears to have influenced their practices. Such insights likely have contributed to better alignment between learning principles and training practices and may continue to drive improvements in how CRG members and their programs approach learning.

The influence of grounded theory and narrative inquiry on constructing the FETP learning process

Grounded theory initially fit the research purpose because I aimed to generate an explanation (i.e., theory) of FETP learning from the data. I gravitated toward Charmaz's (2014) constructivist grounded theory, which, while building on the original approach of Glaser and Strauss (1967), incorporates flexibility in both method and application. Charmaz assumes that 'social reality is multiple, processual, and constructed, [so] we must take the researcher's position, privileges, perspective, and interactions into account as an inherent part of the research reality' (2014, p. 12). She further argues that 'The constructivist approach perspective shreds notions of a neutral observer and value-free expert. [So,] researchers must examine rather than erase how their privileges and preconceptions may shape the analysis [and how] their values shape the very facts that they can identify' (Charmaz, 2014, p. 13). These assumptions align with my constructivist and social constructionist worldview. Additionally, Charmaz's approach provided clear methodological guidance, helping me start the analysis through constant comparison and memo-writing during the open coding phase. This process forced me to start close to the data and identify initial categories related to trainee and

trainer approaches to learning. The involvement of the CRG further reduced the influence of my 'position, privileges, perspective, and interactions' (Charmaz, 2014, p. 12).

Although grounded theory helped to generate the initial coding scheme, I encountered limitations in the constant comparison method. Line-by-line comparison, while intended as a heuristic tool (Gibbs, 2013), seemed to fragment the data arbitrarily, disrupting the broader context of movement, situation, and change. This micro-level analysis often blurred rather than distinguished signal and noise.

Recognizing these limitations led me to narrative inquiry. Citing Clandinin (2013), Patton describes narrative inquiry as focusing on stories, exploring human lives through narratives and honouring lived experiences as legitimate sources of knowledge and understanding (Patton, 2015, p. 128). I employed Polkinghorne's (1995) approaches of analysis of narratives and narrative analysis, particularly as explained in McCance et al. (2001). During the focused coding phase of grounded theory, I shifted to analysing larger sections of transcripts—the stories themselves—to separate signal from noise. I did not, however, fully follow Polkinghorne's method, as I did not examine how participants told their stories. Instead, I noted relevant patterns, such as a participant framing their program as failing expectations or another providing vague and rosy answers rather than detailed stories.

Narrative inquiry suited this investigation of learning because learning is inherently temporal. Describing learning involves acknowledging change over time—situations evolving into outcomes. Narratives offer a structure for relating causes and consequences, challenge and resolution. Through storytelling, one selects from the infinite happenings of the universe and organizes them sequentially to make sense of experience. This is how learning is communicated. Outbreak reports and scientific presentations, for instance, are structured narratives that convey new knowledge through situation (background), challenge (problem statement/objectives), journey (methods and findings), and resolution (discussion—what new knowledge we *learned* from the experience). Likewise, describing learning involves a similar structure: situation, challenge, journey, and resolution, each contributing to identifying what was learned and how. As Connelly and Clandinin note:

> People shape their daily lives by stories of who they and others are and as they interpret their past in terms of these stories. Story, in the current idiom, is a portal through which a person enters the world and by which their experience of the world is interpreted and made personally meaningful. Narrative inquiry, the study of experience as story, then, is first and foremost a way of thinking about experience. Narrative inquiry as a methodology entails a view of the phenomenon. To use narrative inquiry methodology is to adopt a particular view of experience as the phenomenon under study (Connelly & Clandinin, 2006, p. 375 as quoted in Blix et al., 2024, p. 276).

During the narrative analysis, I created program stories to make sense of each program's learning process by synthesizing participants' stories. In retrospect, the construction of the U.S. EIS case in Chapter 3 was also a form of narrative analysis, wherein I constructed a coherent story of how the program recruited trainees and exposed them to challenges to foster learning.

The focus on narratives also introduced limitations. Greenhalgh and colleagues (2005) argue that *trouble* (as harm or the risk of harm) is a defining characteristic of narratives. Certainly, how one navigates trouble differentiates story from anecdote. This emphasis on trouble raises questions: Does learning happen without trouble? If so, can the learner—and thus the researcher—recognize it? Moreover, as the authors note, narrative inquiry emphasizes sense-making and emotional impact over scientific objectivity, and it privileges the unusual over the usual, with stories embedded in the broader context of the place's meta-narrative (Greenhalgh et al., 2005).

Additionally, if narratives are constructed to make sense of an experience, and constructing them is essential to recognizing and communicating learning, would the learning identified in this study have been recognized if the interviewers had not asked specific questions? As Spector-Mersel notes:

> [T]he reality being studied is often created only during the inquiry. This is most prominent when the research data are stories told to the researcher: Those stories were not previously there; they were created for him or her, in his or her presence and under his or her direct and indirect influence. This influence is unavoidable even when the researcher invites the interviewee openly to tell a story with no apparent direction or intervention, for his or her external characteristics and visible social ascriptions…Thus, often the data of narrative research is not "clean", in the sense that it is exclusively the narrators' creation. Rather, it is the co-construction of two (or more) persons (2010, pp. 216-217).

While I did ask participants about typical days and how they learned certain topics, only those responses framed as stories entered the analysis. To address this limitation, I compared narrative findings with the coded participant interview transcripts and participant observation notes that were not in narrative form to reconcile inconsistencies.

Ultimately, I returned to grounded theory to complete the analysis. Comparing the four program narratives resembled the constant comparison method. Gathering and categorizing narratives that referred to trainee-advisor interactions led to categories, echoing the grounded theory approach. This process eventually led to the construction of the spectrum of modes of engagement.

In conclusion, the combination of grounded theory and narrative inquiry proved effective. Grounded theory brought me close to the data and helped identify initial categories. Narrative inquiry distinguished signal from noise, linked situations to outcomes, and uncovered learning processes. Comparing learning narratives with initial categories reduced the risk of overlooking ordinary learning experiences and highlighted key learning processes, their facilitators, and the dimensions of one of them. Combining these seemingly disparate approaches allowed me to overcome the limitations of each and construct findings that I might not have with a single approach.

The usefulness of Lave and Wenger's framework for explaining FETP learning

As noted in Chapter 1, I situated this thesis in constructivism and social constructionism because I believe that knowledge is constructed relative to time and place, not absolute, and that culture determines the way we perceive the world. My values lean toward critical theory, especially the work of Freire (2000/1968), which I hoped to incorporate. Before 2022, I had never heard of Lave and Wenger, but before explaining how their framework became practical for this research, I will clarify why Freire's work did not play a substantial role.

The failure to leverage Freire to explain FETP learning

I hoped to use Freire to analyse FETP learning. His critique of education is, in my view, both accurate and formidable. I revisited *Pedagogy of the Oppressed* (Freire, 2000/1968) and read *Pedagogy of Hope* (Freire et al., 2021/1992) and *A Pedagogy for Liberation* (Shor & Freire, 1987) for the first time. In analysing the EIS case study, I found parallels with Freire's work. For example, Langmuir used 'blind' case studies, which hint at Freire's problem-posing method. The problem-posing method employs objects from the learners' world to create learning situations in which the teacher and students engage in dialogue and praxis. In Langmuir's introductory courses, rather than employing the 'banking method' that Freire despised—where students are seen as empty receptacles for teachers to deposit knowledge—Langmuir encouraged working through problems. Outbreak investigations included reflection through writing reports, defending field activities before senior colleagues, and presenting findings and answering questions at conferences—elements that point toward *praxis*. The similarities, however, ended there.

Freire's problem-posing method (Freire, 2000/1968, pp. 96-104) involves more than dialoguing problems. His sixth step involves presenting participants' themes to them as problems. Participants work through those problems, making their consciousness explicit, thus enabling them to recognize and analyse their perceptions, knowledge, and actions. This analysis leads to a new perception of reality and the dialectical relations between perception and background awareness, which produces a novel attitude towards participants' own perceived limiting situation. This process leads to Freire's *conscientização*— 'learning to perceive social, political, and economic contradictions, and to take action against the oppressive elements of reality' (Freire, 2000/1968, p. 35). I found nothing resembling this process in the EIS case, nor in participant observations or interview transcripts from the qualitative study.

Before the reader discounts the Freirean approach as irrelevant, consider that an outbreak investigation is the re-construction of the spatiotemporal distribution of illnesses and transmission pathways. To link consequences with causes, one must construct a narrative of the outbreak, also called a hypothesis. As Hendry (2009) notes:

> [W]hereas science seeks to ask questions about the material world and explain natural phenomenon, the scientist is human and must rely on language (metaphors, stories, symbols) to make sense. While the focus of scientific inquiry is considered to be distinct from other types of narrative, it is dependent to some degree on metaphor and story for its explanations (Hendry, 2009, p. 77).

The great tool of the epidemiologist is the ability to construct a compelling narrative and then assess its validity logically and statistically. To do so requires information from surveillance systems, laboratory reports, and hospital records, *as well as* community members, hospital workers, food-service handlers, patients, animals, etc. The 89-year-old grandmother who sits outside her home all day can spot the unusual and unexpected in her community like any surveillance system can, but she probably does it quicker and with a reasonable hypothesis (narrative) too. So, an effective outbreak investigation is the co-construction of a narrative, which requires dialogue with the community. Moreover, if the goal is to change the social conditions that facilitate the occurrence of disease, the problem-posing method would be helpful.

Yet, the fundamental purpose of EIS and FETP remains disease control, not social transformation or critical awareness. While the foundational FETP did not embrace the banking method, it did not encourage examining social reality beyond epidemiological constructs. Greenough (1995) provides a stark example from the smallpox eradication memoirs of an EIS alum who later led FETPs:

> We considered the villagers to have an understandable though irrational fear of vaccination…We just couldn't let people get smallpox and die needlessly. We went from door to door and vaccinated. When they ran, we chased. When they locked their doors, we broke down their doors and vaccinated them (1995, p. 636).

The purpose of FETP, as envisioned by Langmuir, was technical problem-solving for disease control. In 1952, Langmuir described the program's purpose and the role of the epidemiologist and the community as follows:

> The ultimate objective of this program is to promote a wider understanding and appreciation of epidemiologic approaches to the problem of disease control in peace or war…His [*sic*] competencies are needed to modernize the existing morbidity reporting services and to develop more comprehensive and sensitive indices of morbidity. He should direct and promote the wide use of skilled consultation services for the clinical examination of problem cases, for

> the effective use and correct interpretation of laboratory tests, and for advice to the general practitioner regarding appropriate therapy. The decision whether or not to invoke isolation and quarantine measures should be made on the recommendation of the epidemiologist…Carefully planned public information services would keep the citizens informed of the true facts, of the measures being taken, and of each individual's responsibilities. A practical plan to isolate cases could be instituted, if necessary, and a large measure of voluntary compliance by the public would probably be achieved (Langmuir & Andrews, 1952, p. 237).

Epidemiology, especially mainstream infectious disease epidemiology, upon which EIS and FETP took root, aims to facilitate the social world returning to normal after an aberration and to prevent similar aberrations. It does not ask about the appropriateness of that world. Indeed, modern epidemiology has roots in empire building and slavery (Curtin, 1968; Downs, 2021), which used and developed the epistemology and methods to ensure the success of those enterprises.

Freire's work failed to explain FETP learning processes because he sought a radically distinct end. His framework aimed for social transformation, not technical problem-solving that seeks the survival of the existing social system:

> This book will present some aspects of what the writer has termed the pedagogy of the oppressed, a pedagogy which must be forged with, not for, the oppressed (whether individuals or peoples) in the incessant struggle to regain their humanity. This pedagogy makes oppression and its causes objects of reflection by the oppressed, and from that reflection will come their necessary engagement in the struggle for their liberation (Freire, 2000/1968, p. 48).

This difference in purpose is significant. For Freire, education is not simply about acquiring technical skills but about transforming the social world through critical reflection and action. His pedagogy focuses on challenging oppression and creating new realities rather than maintaining existing ones. This distinction highlights the importance of understanding the theorists' intent when assessing the suitability and explanatory power of their work. It also raises a question: What would field epidemiology look like today had Langmuir embraced Freirean education?

The success of leveraging Lave and Wenger in explaining FETP learning

Although I had never encountered Lave and Wenger's work before 2022, their framework became central to this thesis. It aligned well with the EIS case (Chapter 3),

explained differences across learning environments (Chapter 5), and clarified the importance and dimensions of advisor stewardship for learning (Chapter 6). Lave and Wenger developed their framework while analysing enterprises not unlike field epidemiology, which served this analysis.

Foremost, the enterprise of FETP aligns with Lave and Wenger's focus. They aimed to clarify how learning occurs through apprenticeships and situated learning (1991, p. 31). From its inception, FETP was designed as an apprenticeship model prioritizing learning beyond the classroom. Langmuir's EIS officers described their training as:

> Our training was truly in the classic mode of an apprenticeship…We learned on the job, with little time spent on formal didactic training. Whatever was neglected in the way of formal training was more than compensated for by the drama of dealing with public health problems at a local and national level (Nathanson & Alexander, 1996, p. S34).

Also, field epidemiology constitutes a recognizable COP. The community includes national programs, regional and global networks, conferences, publications, roadmaps, and competencies. Wenger's (1998, chapter 2) three dimensions of community coherence—*mutual engagement*, *joint enterprise*, and *shared repertoire*—are evident within the field epidemiology community.

Furthermore, FETP serves as a clear peripheral zone for the field epidemiology COP. Trainees engage with real-world field epidemiology tasks with reduced risk and responsibility, gaining legitimate peripheral participation until they become full practitioners.

The explanatory power of Lave and Wenger's framework, however, implies a limitation. Their focus on social processes diminishes the individual's experience. In the framework, learning appears with centripetal movement toward full participation, which feels deterministic. This limitation is not a failure of the theory but rather a necessary consequence of its focus. Yet, this perspective may be well-suited to the population perspective emphasized in epidemiology. This limitation points to a contradiction: How can learning be recognized as change—in cognition, behaviour, attitude, etc.—within an individual when the framework describing the learning process emphasizes deterministic social forces that minimize the self?

Synthesis of Findings and Theoretical Contributions

This thesis contributes meaningful knowledge to the FETP and public health workforce development communities by describing historical and contemporary training approaches and learning processes within FETP; situating the approaches epistemologically; explaining FETP's endurance, dissemination, and impact through those approaches; and identifying alignment and misalignment between learning principles and practices. Furthermore, the thesis identifies tools and leverage points to enhance learning within FETP and related public health workforce development initiatives.

The findings explain both historical and contemporary training approaches in FETP, illustrating how learning is facilitated through learning environments, trainee tenacity, and advisor stewardship. By examining these processes through Lave and Wenger's framework of legitimate peripheral participation in COPs, this thesis demystifies the processes and facilitators behind 'learning by doing', where trainees engage in practical, context-based learning that builds competence and confidence over time.

Furthermore, the findings highlight misalignment between the FETP community's focus on curriculum design and the actual learning processes that occur primarily in practice. While formal coursework contributes to learning, it is engagement in real-world public health contexts that produces the most robust learning. To address this discrepancy, I provide several practical recommendations below.

Collaboration with the CRG played a critical role in enhancing the relevance and applicability of these findings. Although the research question did not originate from the FETP community, the participation of its members in the research process contributed to improved methods and analyses, as well as more relevant findings. Their participation also directly informs better alignment between learning principles and training practices within their own programs.

The combination of grounded theory and narrative inquiry proved essential for constructing findings that I might not have by using one or the other. Together, they produced this thesis's novel contributions: clarification of the FETP learning process, identification of the key learning process facilitators, and explanation of the dimensions

of advisor stewardship, including development of the spectrum of advisor engagement. As complementary approaches, these methods enabled a more comprehensive understanding of how learning occurs in FETP.

The success of applying Lave and Wenger's framework reflects the suitability of their model for explaining FETP learning processes. By effectively describing how trainees learn through interacting with the COP's learning curriculum as they progress from peripheral to full participation, their framework clarifies how learning environments, advisor stewardship, and trainee tenacity interact to facilitate learning. This thesis extends their work by describing how advisors steward trainee learning in the periphery through opening the practice, bestowing legitimacy, and interacting through adaptive modes of engagement. The findings also suggest, however, that their framework's explanatory power is limited when it comes to understanding the role of the individual in learning, specifically with respect to psychology—such as motivations, perceptions, and intentions—and the recognition of learning as an individual experience, where changes in knowledge and skills are often identified and understood within a single person.

Ultimately, findings from this research provide both theoretical insights and practical tools that can inform the design, implementation, and evaluation of FETPs, as well as other apprenticeship-type, health professional education programs. They inform recommendations for those who fund, design, develop, and lead such efforts in hopes of enhancing learning.

Recommendations For Facilitating Learning

1. Reinforce the national field epidemiology COP.

In view of the findings, FETP is not about learning *per se:* it is about structuring a peripheral zone for individuals to transition to central membership in the field epidemiology COP, that is, to become practicing field epidemiologists. Through that transition, they learn. Wherever there are professionals doing field epidemiology, there is a field epidemiology COP. Without that COP being clearly identifiable and engageable, however, trainees will struggle to make sense of the tasks, roles, and responsibilities assigned to them and struggle to imagine themselves as practitioners

after FETP. So, even tenacious trainees will find it difficult to remain engaged in the learning process.

The current drive towards One Health field epidemiology provides an illustrative example. While substantial efforts are directed toward building One Health curriculum and One Health FETPs, discussions at regional and global conferences tend to highlight agreement with the direction and confusion as to how to implement it. Though the current approach will broaden awareness, without a One Health field epidemiology COP, trainees will fail to make sense of what a One Health field epidemiologist is and does, complicating their acquiring the expected competence.

Instead, blending the COPs of human, animal, and environmental health will allow an integrated One Health COP to emerge at their intersection. Clarification and support of that integrated COP enterprise and its members will further its development. As the One Health COP develops, it will open the practice to FETP trainees through projects, tasks, roles, responsibilities, and advisor stewardship that will build their One Health competence.

Reinforcing the field epidemiology COP could further ameliorate at least five FETP challenges. Although FETPs overlap and a global field epidemiology COP exists, each country has its own field epidemiology COP responsive to the needs and contexts of the country. Reinforcing the national COP will clarify what successful engagement in the national field epidemiology enterprise entails, thus addressing firstly the challenge of what competencies trainees require (see Figure 7.1), secondly the challenge of how to balance expected global and local competencies, and thirdly the challenge of 'a credentialing system for individuals…to verify competencies of field epidemiologists' (The Task Force for Global Health, 2018, p. 19) from diverse programs because ultimately what matters is that the national COP can address national population health needs and because any competencies, whether developed globally or locally, are learned through local contexts as demonstrated in the FETP learning process described in this thesis. Fourthly, the challenge of securing suitable advisors, whether full-time, part-time, or project-based, will be addressed because COP members will be recognized as members thereby identifying a pool of potential advisors and motivating them to engage trainees as essential to continuing and strengthening their COP.

Finally, the challenge to 'potentiate the mobilization of trained FETP graduates for the provision of mutual, cross-border assistance' (The Task Force for Global Health, 2018, p. 7) will be addressed. Problems in the fly-in-fly-out investigation approach have been shown to relate not to technical but to interpersonal skills and lack of contextual understanding (Holding et al., 2019; Parry et al., 2021). This thesis elucidates an underlying reason for this limitation: trainees learn the field epidemiology enterprise—the tools and tacit understanding of how to apply them in practice—in one context but then attempt to apply them in a different context of which they have little understanding. Surge deployments should therefore employ mature field epidemiology practitioners who have experience engaging in legitimate peripheral practice in diverse contexts, for example, through study tours, short non-emergency deployments, and joint investigations with reduced responsibilities and risk. In other words, cross-border field epidemiologists should comprise a separate COP with its own periphery, which should be reinforced.

Importantly, this recommendation does not mean *creating* a COP because one already exists. Instead, FETP funders, designers, developers, and leaders should reinforce national field epidemiology COPs by:

- Assessing how the COP provides legitimacy and peripherality to trainees, facilitates mutual engagement with domestic field epidemiologists and access to COP activities, negotiations of meaning, and shared repertoires and then using assessment findings to guide COP strengthening[3].
- Identifying and recognizing members of the national field epidemiology COP and supporting the emergence of its leaders.
- Facilitating COP members to define the enterprise clearly, stipulating what national field epidemiologists do and how they do it in the national context.
- Facilitating members to clarify the repertoire of knowledgeable tools that the COP uses to engage in and make sense of the enterprise.
- Supporting members' regular and mutual engagement with one another and with FETP trainees.

[3] Wenger et al. (2002) identifies common 'disorders' of communities of practice with proposed countermeasures that can guide assessment and intervention.

- Engaging the COP regularly on questions related to the direction of FETP, such as recruitment strategies, with a view towards enhancing the COPs ability to successfully carry out its enterprise.

2. Repurpose intensive courses to maximise their learning potential.

The principal misalignment between learning principles and training practices revealed through this thesis was the focus on curriculum when learning happens more often in practice. Major efforts (see *Guidance for One Health field epidemiology curriculum development: a supplemental manual to the Competencies for One Health field epidemiology (COHFE) framework*, 2023; Traicoff et al., 2008) have invested in designing curriculum for FETP. Co-researchers of the qualitative study indicated that their programs spend substantial resources on intensive courses, but they struggle to provide content that meets the needs of trainees with diverse backgrounds, experiences, and knowledge. We identified robust learning in routine placement work, projects, and field investigations and less robust learning in intensive courses, which Lave and Wenger (1991) explain as newcomers being sequestered from practice and forced to interact with knowledge disconnected from practice, resulting in their difficulty to grasp the meaning of the enterprise and tasks at hand.

Intensive courses have always been a pillar of FETP. Whereas the foundational FETP relied on discussion-based case studies (see Chapter 3), participant observations and interviews in the qualitative study of contemporary FETPs showed a reliance on didactic lectures. Intensive courses, however, have many uses beyond providing content. They connect new cohorts of trainees to one another and to their advisors, connect programs to external subject-matter experts who could support trainee projects and investigations, help trainees identify learning resources, offer opportunities to practice skills like interviews in simulated contexts and present the stories of mature practitioners that engage trainee motivations to learn or, alternatively to exit the course early. They also provide advisors with an opportunity to assess new trainees' attitudes, knowledge, and skills, facilitating their assigning of advisors, projects, roles, and responsibilities. Wenger asserts that classroom instruction is not useless but that it should supplement—not substitute—learning opportunities in practice. He suggests interspersing information-sharing and reflection sessions with

peripheral practice instead of front-loading trainees with classroom content (Wenger, 1998, p. 250). He also notes that because of readily available resources like online courses, access to a curriculum is not a challenge for students (University of Brighton, 2013, 43:03).

To maximize the learning potential in intensive courses, strengthen them by:

- Engaging adult learning professionals in the design, development, and initial delivery to ensure alignment with contemporary adult learning practices and principles and/or educating FETP advisors in adult learning principles and practices.
- Integrating fieldwork and course work by aligning learning objectives and outcomes, including field-based experience-sharing and reflection in courses, and extending classroom exercises into field experiences.
- Separating longer introductory courses into multiple, shorter courses delivered at intervals with trainees engaged in legitimate peripheral practice between them.
- Bringing the practice into the classroom by centring courses on group-based problem-solving[4], derived from problems (e.g., outbreak investigations, surveillance evaluations, surveillance data analyses) that the national COP addressed or tried and failed to address in the national context, ensuring that these problems incorporate the necessary competencies for trainees to learn through doing, discussing, reflecting, and researching.
- Engaging trainees with local cultures and knowledge. This can be achieved by inviting members of diverse local communities to participate in the course—both to share their perspectives on health and disease and to take part in group-based problem-solving discussions.
- Integrating substantial reflection into group-based problem-solving activities, e.g., through exchanging solutions among groups for peer feedback, facilitating small and large group reflective discussions, and journaling. For some problems

[4] Although 'case studies' are a cornerstone of FETP courses, I hesitate to use the term here, for during participant observations I observed 'case studies' that were little more than didactic presentations of a case with a few questions peppered throughout the lecture.

with particularly complex social dynamics, use a Freirean problem-posing approach to facilitate trainees to re-perceive their understanding of and participation in the power dynamics and how those influence health and illness and to raise their awareness of social transformation as a health intervention.

- Including activities that facilitate participants to share and discuss experiences from engaging in legitimate peripheral practice (e.g., their projects, assignments, and field activities) to reinforce learning and facilitate cross-learning.

3. Cultivate trainee tenacity.

Trainee tenacity, which I defined as a combination of resourcefulness, motivation, and perseverance, was one of three key facilitators of the FETP learning process. It thus represents a leverage point for enhancing learning.

Educational and psychological research has shown that traits like these are identifiable and modifiable. For instance, psychology professor and MacArthur 'Genius' Fellowship awardee Angela Duckworth has published extensively on 'grit', which she defines as passion and perseverance for long-term goals (Duckworth et al., 2007). Her work includes the development and testing of psychometric scales on grit (Duckworth & Quinn, 2009), the reciprocal relationship between grit and growth mindset in Asian populations (Zhang et al., 2022), and the predictive power of grit for completing commitments across a range of adult contexts (Eskreis-Winkler et al., 2014). In another example, Kennett and Reed (2009) show how resourcefulness can be taught to students and that doing so improves academic performance. Such work could guide efforts to identify tenacity among trainees and cultivate it.

To enhance the learning process, cultivate trainee tenacity by:

- Incorporating tenacity into the recruitment selection process, for example by asking candidates to describe experiences that demonstrate their tenacity.
- Clarifying the importance of tenacity in the FETP learning process to trainees when they begin the program, for example by presenting the findings of this and other relevant research and having them work through representative case stories that demonstrate previous trainees employing tenacity to complete projects, overcome challenges, and graduate, using such case stories to

facilitate trainees to identify their own strengths and weaknesses for tenacity and commit to improving it.

- Incorporating challenges into intensive course problems that require trainees to use tenacity, such as leveraging their resourcefulness to find information to solve problems and discussing strategies employed and strategies overlooked.
- Conducting sessions with advisors on the dimensions of trainee tenacity and how to strengthen it, for example by reviewing the findings of this and other relevant research as well as case stories of trainees and advisors leveraging trainee tenacity.
- Employing tools to clarify trainee needs, learning strategies, and assessment outcomes and methods, such as Knowles's learning contract (Knowles & Associates, 1984).

4. Invest in advisors' capacities to steward the field epidemiology COP periphery.

The findings demonstrated the essential role of advisor stewardship in facilitating trainee learning. Through opening the practice, bestowing legitimacy, and employing adaptive modes of engagement, advisors shape trainee learning. Investing in their development as stewards of the periphery will facilitate the FETP learning process.

Additionally, FETP advisors rarely learn how to train, mentor, or supervise systematically, i.e., other than on the job. Among advisors participating in the qualitative study, none had received instruction or training in these roles. They became advisors primarily because they wanted to do field epidemiology at the national level.

Therefore, developing advisors' capacities as periphery stewards and jumpstarting those of new advisors is essential and should include:

- Developing an assessment (or self-assessment) tool based on the dimensions of advisor stewardship and spectrum of adaptive modes of engagement described in this thesis to facilitate advisors recognizing their strengths and weaknesses for stewarding the periphery and planning to leverage those strengths and address those weaknesses.
- Conducting workshops with advisors on periphery stewardship that include, for example, presentations of the findings of this and other relevant research and

group-based discussions of case stories of advisors stewarding trainee learning through projects, assignments, and challenges.

- Ensuring advisor availability to trainees by achieving sufficient advisor-to-trainee ratios for the context, clarifying expectations of time and availability commitments, and setting minimum meeting schedules that account for each advisor's availability and style and their trainees' needs.
- Employing tools to clarify advisor and trainee expectations and monitor progress, such as Knowles's learning contract (Knowles & Associates, 1984) and the supervisor-scholar contracts used in the Australian FETP.

5. Ensure ample and diverse opportunities for trainees to engage in FETP learning environments.

The findings here showed that learning environments are one of three key facilitators of the FETP learning process. They provide a context and reason for engaging in legitimate peripheral field epidemiology practice. Ensuring trainees engage in them regularly will enhance learning.

Program leaders, however, may overlook the value of learning from routine work. Outbreak investigations—filled with mystery and the potential to heroically save lives—naturally pique motivation; yet most of the work of a field epidemiologist is less dramatic: attending meetings, reviewing case forms, discussing weekly surveillance trends, preparing surveillance reports. In addition, few trainees in the qualitative study participated in more than a single outbreak investigation. To strengthen learning, we must maximize the opportunities found in routine work and projects, which offer rich and sustained exposure to the skills and knowledge a field epidemiologist needs.

Several actions can maximize the learning potential of trainees, including:

- Assigning trainees routine roles and responsibilities at their work placement for legitimate peripheral field epidemiology work that incorporates supervision, reflective discussion, and feedback. I have included an example of such a structured placement assignment from one FETP in Chapter 5.
- Providing opportunities for trainees to join diverse field experiences beyond outbreak investigations, such as those described by trainees in the qualitative study like checking mosquito traps with an environmental scientist,

accompanying food-service inspectors and long-term-care-facility inspectors on rounds, and attending community vaccination day campaigns.

- Assigning trainees projects that meet the needs of the national field epidemiology COP (or program requirements), the needs of the placement, as well as the interests of the trainee—viewing each as one circle in a Venn Diagram and finding the overlapping areas—including surveillance evaluations, surveillance data analyses, intervention evaluations, and epidemiological studies, for example, and focusing on projects that expose them to the boundaries of the field epidemiology COP, like zoonotic diseases and environmental toxin monitoring. One FETP in this study incorporated a group project (see Chapter 5), which provided a valuable opportunity for legitimate peripheral practice.

Future Research to Inform FETP Learning

In addition to recommendations for policy and practice, this thesis has identified several areas for future research to inform FETP learning. First, given that these findings derive from the case study of one program and a qualitative study of four programs, they do not represent the situation of all FETPs. No Frontline programs or low-income countries participated in this research, neither did FETPs from the Americas, Africa, or Europe. Therefore, studies exploring the applicability of the findings from this thesis to other FETPs would be beneficial. Also, as described above, the CRG contributed to and benefitted from participation in this research with a just and practical approach to research. I therefore encourage researchers exploring FETP to embrace the participatory approach in the form of a CRG while considering FETP leaders' competing priorities that impact participation. This recommendation applies to program evaluations as well as to research.

Additionally, the importance of the three key facilitators to the FETP learning process—advisor stewardship, trainee tenacity, and learning environments—offer ripe areas for further research. I especially encourage further explanation into the two where I focused less: trainee tenacity and learning environments. Furthermore, though I intended to use other theories, I ultimately relied on the work of Lave and Wenger. The

suitability to FETP was strong, explanatory power useful, and limitations apparent. So, I encourage exploration of how other theories might elucidate other aspects of the FETP learning process, especially those focusing on culture and with feminist, embodied, and post-human lenses.

Finally, this research invites reflection on deeper ontological questions about the nature of the self in learning. Learning is typically understood as a change within an individual—shifts in cognition, attitudes, neural pathways, behaviour, or competence. Wenger (1998), however, argues that identity is not within an individual but emerges participation in COPs. In other words, one joins FETP to *become* a field epidemiologist more than to *learn* field epidemiology. Learning, in this view, is a process of identity formation, shaped through engagement and disengagement with COPs. A person's identity is thus the constellation of their COPs.

Yet, if identity is always in flux, continually redefined through shifting forms of participation, what—if anything—is constant? What is the self that moves from peripheral to full participation? And if both COPs and their members are constantly in flux, is there a stable entity to call an 'individual' at all? These questions challenge us to reconsider what it is that we claim to measure and identify with 'learning.'

Research may help. Dall'Alba (2009) has employed the ontological work of Heidegger and Merleau-Ponty to emphasize professional ways of *being* rather than just *knowing* or demonstrating competence in professional development. Her work provides a rich avenue for exploring these questions. Given the dominance of competency-based education, such ontological inquiry is not only attractive—it is necessary.

Conclusion

This thesis began with a concern for standardized approaches to training, a fascination with the influences of culture, gender, and context on shaping learning and epistemology and thus a desire to understand learning. It has concluded by uncovering not only how, but also why, and under what conditions learning happens in FETP. By examining historical and contemporary practices, my research explained learning as a social process shaped and facilitated by learning environments, trainee tenacity, and advisor stewardship. It reframed FETP as a structured periphery of the field

epidemiology COP, and it provided tools to inform program design and delivery; yet it also concludes with an invitation for reflection on misalignments, contradictions, and questions about epistemology and ontology. In doing so, this thesis constructs a bridge between theory and practice, the individual and the construction of the social world, and technical competence and professional becoming. For funders, designers, and implementers of FETP and apprenticeship-like health professional education programs, it offers practical recommendations for enhancing learning. For learning professionals, it extends an established learning theory and offers direction to contribute to the construction of knowledge and to addressing real-world practical problems like the next COVID-19. For me, it represents both a contribution to academic discourse and a pathway to influencing global health security and workforce development.

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Chapter 8 APPENDICES

Appendix A. Protocol for Participant Observation

Administrative

1. **Confirm program participation in the participant observation**—the program director should have signed the Letter of Agreement for the program to participate in the participant observation and returned it to the PI prior to commencing the observation.
2. **Clarify the level of participation with the program leadership**—
    a. Agree on the starting and ending dates and times of the observation period.
    b. The program should conduct events in the language and manner normally used. This means assigning the appropriate role to the PI, such as trainer, co-facilitator, experienced epidemiologist, etc. If translation is required, it should be done in a way that minimizes the impact on the participants.
    c. The PI can engage in informal conversations with trainers and trainees about the training and learning event(s) and will consider these discussions as potential data.
    d. The PI will record observations and discussions with the participants in a minimally obtrusive manner, typically through jot notes to be transcribed into field notes after the events of the day.
3. **To begin, introduce the PI, participant observation, and voluntary participation—**at the start of the participant observation, the director or co-investigator will introduce the PI and clarify his role in the event, including the data collection.
    a. The co-investigator and PI will explain that participants should continue about their normal activities, that the PI may observe these activities, may converse with participants, and may record observations and conversations for use in the study, and that all data will be de-identified.
    b. The co-investigator and PI will remind participants that they may withdraw from the study at any time by informing any of the program leaders or the PI without questions or necessary explanation.
    c. For any potential participant who requests not to participate, the program staff/co-researcher will explain to the participant two options: 1) to stop the participant observation altogether (or at least for the events and activities in which that person will be present) or 2) to proceed with participant observation with the researcher not recording any information (descriptions, words, etc.) about that participant.
    d. The co-investigator and PI will answer any questions from participants.
4. **Conduct the participant observation**—the PI will participate in the events and observe them according to the agreement with the program leadership (details below).
5. **Conclude the participant observation—**at the conclusion of the participant observation, the PI will remind participants how their information will contribute

to the study and will discuss with the participants any part of the participant observation that they would like to discuss.

a. The PI will inform the participants that they can participate in a debrief of the findings at the end of the study, if interested, and will arrange with program leaders for the debrief.
b. The PI will provide his contact information and a link to the webpage where published findings will be housed.

Conducting the Participant Observation

Attend to everything that other people are doing

- Language and dialect on training and learning in field epidemiology.
- Diversity within the setting or group, e.g., age, gender, educational background, professional background, status and role in context, motivations, ethnic identity, native language, family lifestyle.
- Activities and story lines: the segments of action, the regular, nonvarying components and more variable items, variations in story line that might reflect background, motivation, context, etc.
- Moments of engagement and disengagement (distraction, confused looks).
- Moments of intentional teaching/training, including supervision and mentoring.
- Moments of explicit and tacit learning, intentional and unintentional, including in supervision and mentoring.
- Aha! [learning] moments.
- Moments of application or need for non-technical skills and traits.
- Trainee and trainer expectations, motivations, words versus behaviours.
- The feeling and experience.

Data include

- Details of physical spaces, people within that space, activities, and movements of people in a scene, maps of physical and social setting.
- Interactions among people and with the researcher.
- Words spoken or written.
- Nonverbal communication.
- Counts (people, desks, windows, etc.) in every situation.

Collect data by

- Asking to participate in events, meetings, lunch, break, walks, field work, etc.
- Informally observing activities.
- Engaging in conversations (informal interviews) with participants (follow participants' lead, avoid guiding the topic or flow).
- Recording (writing, no taping) everything:
    - Verbatim quotes wherever possible.
    - Words, special language, terms, and vocabulary.
    - Impressions, thoughts, concerns, explanations.
    - Description of physical context, people involved, their behaviour and nonverbal communication.

— Jot notes—words, phrases, sentences, drawings, dates, times, numbers, reminders in a notebook during events to help memory later.
    - Jot down as soon as possible, within minutes.
    - Translate to field notes as soon as possible.
— Field notes—detailed notes during quiet time, reflecting on events of the day. Aim for high level of detail. Note, methodological choices, including how observations were made, under what circumstances, and how they were recorded. Read field notes and comment on them in the field while there is still opportunity to fill in gaps.
— Protect the anonymity of informants—change the names of individuals, or assign them numerical codes, create a single identification key at some point in the analysis process, and then destroy materials that have the original names included.

Appendix B. Interview Guides

Interview Guide for Trainees

Prior to connecting with interviewee

☐Review the Tips for interviewing.

☐Ensure to read and have on-hand the "Distress protocol for interviewers conducting interviews"

☐Ensure to have on-hand and follow any instructions or guidance on cultural safety for this program or its participants.

☐Test the microphone and speakers. Test the recording and the saving of the recording to a password-protected folder on the ANU server (i.e., your assigned folder on SharePoint).

☐Prepare and test a back-up recording device, such as a phone, in case that the participant does not want a video recording made.

Prior to starting the interview

☐Welcome the interviewee and remind the interviewee who you are. Note, it is a good idea to engage in some chit-chat (e.g., where are you today? How is the weather there?) before getting into the interview business).

☐Thank the interviewee for agreeing to do the interview. Ask the interviewee how you should call them, e.g., Dr Hoang or Samantha or Sam?

☐Explain that

1. We are conducting interviews with FETP trainers and trainees in four programs
2. The purpose of the interview is to learn how people train and learn in FETP

☐Remind the interviewee that

1. participation is voluntary
2. interviewee can decline or withdraw at any time without explanation
3. interviewee can skip any question in the interview
4. interviewee can withdrawal the interview from the study at any point up until data are prepared for publication

☐Explain that the interview will focus on the interviewee's experience in the [name of FETP] and should last one to two hours. The interviewee can take a break whenever necessary.

☐Clarify that should we wish to use any of the interviewee's quotes in published material, we will check with the interviewee first to ensure confidentiality and comfort. Also explain that the interviewee does not need to worry about naming places or people because those will all be replaced with generic terms, like 'supervisor' or 'province' or 'health department' or 'trainee.'

☐Ask if there are any questions about the research or the interview. (See the participant information sheet to answer any questions. If you cannot answer a question, say that you will find out and get back to them. Make a note and ensure to follow up.)

☐Request permission to record the interview. Say that you would like to [video/audio] record the interview to ensure the transcription is accurate, and that the investigators will destroy the recording after analysis.

☐Start the recording.

☐Verify the recording is working.

Conducting the interview

Take strategic, focused notes to help formulate new questions, inform analysis and back up recording failures. You do not need to take verbatim notes.

Start with informal, impersonal questions to establish a casual, friendly atmosphere.

Move from easier, descriptive, less sensitive, less evaluative questions to more sensitive, evaluative, analytical questions. Once you have set a casual, friendly atmosphere, ask questions to help the interviewee narrate stories about their experience in FETP. The flow should be natural, like a conversation between two colleagues but with one of them (you) much more interested in listening to the other.

Ask probing questions to help the interviewee narrate richer stories. Probes help to follow up incomplete responses with clarifying questions. Interviewees will soon learn what degree of depth and detail you seek through probes. *Why…?* is not a good probe. Examples of probing questions:

- [Detail-oriented questions on who, where, when, and how. . .?]
- *It would be helpful to hear more about that.*
- *Tell me more about what happened and how you were involved.*
- *That seems important to you. Tell me about it.*
- *What role did you play?*
- *What did learn by doing that?*
- *How did you prepare for that?*
- *How did you know that you should do that?*
- *Tell me more about your thinking at that time.*
- *I am interested in the emotional side of that experience. What were you feeling then?*

- *What did you like about . . .?*
- *What frustrated you about . . .?*
- *What do you think about that?*
- *What opinions do you have about that now?*
- *What helped you understand that?*
- *Suppose I was watching this experience happen. What would I see? Take me there.*
- *What similar experiences have you had in the past?*
- *How do previous experiences compare to this one?*

Use transitions to move between topics. Natural flow of conversation is ideal, moving from one topic to another, but it is also acceptable to change topics when you feel that one topic has been discussed enough. Examples:

- Let us change topics for a bit . . .
- Thank you for sharing that . . . Can we move to . . .?
- Now, I would like to know about . . .
- We have been talking about . . . Now, I would like to ask you about . . .
- *I want to move to . . . Before we do, let me make sure I have understood what you have been saying about . . .* [Summarise.]

Topics for interviewing

Early questions

☐ Motivation – aim for stories that illustrate what motivates the interviewee to learn field epidemiology.

- *What brought you to public health? Tell me your public health journey.*
- *What brought you to field epidemiology? How did you discover field epidemiology?*
- *What brought you to FETP? What is your FETP story?*

☐ Context/Interviewee world – aim for descriptions of the interviewee's day-to-day experience with FETP.

- Tell me about a typical day for you. What did you do yesterday? Walk me through it.
- If I followed you around for a day, what would I see and hear?
- What are your main roles or projects?

Mid-interview questions

☐ Outbreak investigation – aim for outbreak investigation experiences that illustrate how the trainee learned to perform during outbreak investigations.

- *What was the last outbreak you investigated? Tell me about it. How was it different from previous investigations for you?*
- *What was your first outbreak investigation like?*
- *What frustrating experiences have you faced during an outbreak investigation?*

☐ Surveillance – narratives that illustrate how the trainee learned to conduct public health surveillance, including evaluation of surveillance, and analysing surveillance data.

☐ Communication –stories of how the trainee learned to communicate epidemiology to different stakeholders, like decision-makers, communities, and teammates.

☐ Epidemiologic methods – stories on how trainee learned to design and conduct epidemiologic studies, including descriptive and analytical epidemiology.

☐ Courses/classes – narratives of trainee's learning experience with FETP courses or classes, like the introductory course and topic-based courses.

Late-interview questions

☐ Mentoring – stories of the trainee's experience with FETP mentor(s) or other formal or informal mentor. By 'mentor,' we mean someone who guides the trainee, formally or informally, on field epidemiology other professional or career topics.

- *Who mentors you for field epidemiology? Tell me about that relationship.*
- *What is a [good/frustrating] experience you have had with your mentor?*
- *What other people have helped you along the way in this programme?*

☐ Supervising – narratives of the trainee's experience with FETP supervisor(s). By 'supervisor,' we mean a person contractually assigned the professional role of supervising the trainee. These people may be field supervisors, academic supervisors, job supervisors, etc.

- *Who supervises you in field epidemiology? Tell me about that relationship.*
- *What is a [good/frustrating] experience you have had with your supervisor?*

☐ Training/learning – stories indicating the trainee's experience with training and learning in FETP that have not been mentioned already.

- *What is the [most important/most difficult] thing to learn in FETP? What did you do to learn it? How do you know you have learned it?*
- *What do you do to learn field epidemiology? When you struggle with something, what do you do? Describe your process. Give me an example.*
- *Who is your favourite trainer or facilitator? Tell me about a time you benefitted from interacting with that person.*
- *Tell me about a [joyful/pleasant/frustrating/difficult] time you have in this programme.*

• *What is the biggest change that you have seen in yourself since starting this program? Tell me about that. How did it come about?*

• *In what ways does your experience in FETP differ from others? For example, in terms of gender, background, age, culture, etc., how has your experience been easier or more difficult from others in your cohort?*

• *What is the bigger picture of you and this programme? How does everything you have been doing in this programme fit within a bigger picture? What are you trying to achieve?*

Near the end, offer the interviewee space to lead. When you feel that the interviewee is getting to the end, or at least 15 minutes before the scheduled end time, ask the following two questions**:**

• *What else do you think I should ask or know?*

• *What questions do you have for me?*

Close with a positive note. Acknowledge the contributions the interviewee has made [e.g., to the study, to the nation's health, to the country's public health system, as appropriate] or how much the interviewee has learned. Thank the interviewee. Remind the interviewee of the follow-up procedures (described in "Post interview").

Post interview – Before ending the call, cover the remaining administrative issues. Keep the recording going.

☐Acknowledge that you will send a draft transcript for the interviewee's review and concurrence.

☐Remind the interviewee that no quotes will be attributed to them in published work and that we will do our best to remove identifying words from the quotes to maintain confidentiality. Explain that before using any of the interviewee's quotes in published work, we will clear them with the interviewee.

☐Clarify that interviewees can access study findings at https://tinyurl.com/FETPLearning.

☐Note that interviewees can participate in a debrief of the study findings, if interested. Ask if they are interested and note their response.

☐Say that you may contact them for a follow-up interview in the coming months. Ask if that would be ok and note their response.

☐Explain that some learning experiences can be unexpected, so if the interviewee feels at any point in the next couple of months that they have learned something and want to discuss it with you, the interviewee should contact you or the PI to schedule an interview.

☐Remind the interviewee that you could also do an interview after a planned event, like a course or a conference presentation or the completion of a project, so you can explore the learning in that event. If the interviewee is open to this, discuss timelines and dates with the interviewee to schedule a next interview. Do not pressure the interviewee to schedule now. Note that you can check back with the interviewee in a month or two, if preferred.

☐Remind the interviewee that participation is still voluntary. The interviewee can withdrawal the interview from the study at any point up until data are prepared for publication. Provide the contact information for the PI [Redacted]. Explain that the interviewee can contact him or you at any time to remove the interview from the study.

☐Confirm that the interviewee is willing to use the interview data in the study.

- If the interviewee decides not to use the interview data, do not try to convince them. Acknowledge their response. Ask if there is anything they would like to discuss. Discuss it. Remind them of the confidentiality. Remind them that we will not attribute their words to them and that we will check with them before using any of their quotes in publications. If they would still like to withdraw from the study, thank them for their time and let them know their data will be destroyed immediately.

☐Thank the interviewee again.

☐Stop the recording.

☐Write down any notes, reflections, thoughts, concerns, etc., including the context of the interview, the connection quality, any interruptions, the in which you and the interviewee conducted the interview, etc. Write down any observations you have about the interviewee's state of mind during the interview, any reactions you remember, when they happened, and what you thought about them. Write down also any thoughts you have about your own performance as an interviewer, what you felt you did well and what you want to improve for the next interview. Save these on a word document with the suffix RFLXNS (e.g., 21_INTERVIEW_1_002_RFLXNS.docx) in your SharePoint folder. Please provide English translation of the reflections on the same document.

☐Store the recording and your notes in your SharePoint folder.

☐Transcribe the recording as soon as you are able.

Interview Guide for Trainers (Advisors)

Prior to connecting with interviewee

☐Review the Tips for interviewing.

☐Confirm that the interviewee has signed the informed consent document.

☐Ensure to have read and have on-hand the "Distress protocol for interviewers conducting interviews"

☐Ensure to have on-hand *and follow* any instructions or guidance on cultural safety for this program or its participants.

☐Test the microphone and speakers. Test the recording and the saving of the recording to a password-protected folder on the ANU server (i.e., your assigned folder on SharePoint).

☐Prepare and test a back-up recording device, such as a phone, in case that the participant does not want a video recording made.

Prior to starting the interview

☐Welcome the interviewee and remind the interviewee who you are.

☐Thank the interviewee for agreeing to do the interview.

☐Explain that

1. we are conducting interviews with FETP trainers and trainees in four programs
2. the purpose of the interview is to learn how people train and learn in FETP

☐Ask if there are any questions about the research or the interview. (See the participant information sheet to answer any questions. If you cannot answer a question, say that you will find out and get back to them. Make a note and ensure to follow up.)

☐Remind the interviewee that

1. participation is voluntary
2. interviewee can decline or withdraw at any time without explanation
3. interviewee can skip any question in the interview
4. interviewee can withdrawal the interview from the study at any point up until data are prepared for publication

☐Explain that the interview will focus on the interviewee's experience in the [name of FETP] and should last between one and two hours. The interviewee should feel free to take a break whenever necessary.

☐ Request permission to record the interview. Say that you would like to [video/audio] record the interview to ensure the transcription is accurate, and that the investigators will destroy the recording after analysis.

☐Start the recording.

☐Verify the recording is working.

Conducting the interview.

Take strategic, focused notes to help formulate new questions, inform analysis and back up recording failures. You do not need to take verbatim notes.

☐**Start with informal, impersonal questions** to establish a casual, friendly atmosphere. Examples:

Move from easier, descriptive, less sensitive, less evaluative questions to more sensitive, evaluative, analytical questions. Once you have set a casual, friendly atmosphere, ask questions to help the interviewee narrate stories about their experience in FETP. The flow should be natural, like a conversation between two colleagues but with one of them (you) much more interested in listening to the other.

Ask probing questions to help the interviewee narrate richer stories. Probes help to follow up incomplete responses with clarifying questions. Interviewees will soon learn what degree of depth and detail you seek through probes. *Why…?* is not a good probe. Examples of probing questions:

- [Detail-oriented questions on who, where, when, and how. . .?]
- *It would be helpful to hear more about that.*
- *Tell me more about what happened and how you were involved.*
- *That seems important to you. Tell me about it.*
- *What role did you play?*
- *What were you hoping to accomplish by doing that?*
- *What do you feel you accomplished by doing that?*
- *How did you prepare trainee(s) for that?*
- *How did you teach . . .?*
- *Tell me more about your thinking at that time.*
- *I am interested in the emotional side of that experience. What were you feeling then?*
- *What did you like about . . .?*
- *What frustrated you about . . .?*
- *What do you think about that?*
- *What opinions do you have about that now?*
- *What helped you understand that?*
- *How has that changed your practice/approach?*
- *Suppose I was watching this experience happen. What would I see? Take me there.*

- *What similar experiences have you had in the past?*
- *How do previous experiences compare to this one?*

Use transitions to move between topics. Natural flow of conversation is ideal, moving from one topic to another, but it is also acceptable to change topics when you feel that one topic has been discussed enough. Examples:

- *Let us change topics for a bit . . .*
- *Thank you for sharing that . . . Can we move to . . .?*
- *Now, I would like to know about . . .*
- *We have been talking about . . . Now, I would like to ask you about . . .*
- *I want to move to . . . Before we do, let me make sure I have understood what you have been saying about . . .* [Summarise.]

Near the end, offer the interviewee space to lead. Fifteen minutes before the end, or when you feel that the interviewee is getting to the end, ask the following two questions:

- *What else do you think I should ask or know?*
- *What questions do you have for me?*

Close with a positive note. Acknowledge the contributions the interviewee has made [to the study, to the nation's health, to the country's public health system, as appropriate] or how much the interviewee has learned. Thank the interviewee. Remind the interviewee of the follow-up procedures (described in "Post interview").

Topics for interviewing

Early interview questions

☐ **Motivation** – aim for stories that illustrate what motivates the interviewee to train field epidemiologists.

- *What brought you to public health? Tell me your public health journey.*
- *What brought you to field epidemiology? How did you discover field epidemiology?*
- *What brought you to FETP? What is your FETP story?*

☐ Context**/Interviewee world** – aim for descriptions of the interviewee's day-to-day experience with FETP.

- *Tell me about a typical day for you. What did you do yesterday? Walk me through it.*
- *If I followed you around for a day, what would I see and hear?*
- *What are your main roles or projects?*

Mid-interview questions

☐ **Outbreak investigation** – aim for outbreak investigation experiences that illustrate how the trainer teaches trainees to conduct an outbreak investigation.

• *What was the last outbreak you supported as a trainer? Tell me about it.*

• *What do you do to prepare a trainee for an outbreak investigation? Give me a recent example.*

• *What [positive/frustrating] experiences have you faced with trainees on an outbreak investigation?*

☐ **Surveillance** – narratives that illustrate how the trainer facilitates trainees to learn public health surveillance.

• *One of the core competencies of field epidemiology is public health surveillance. I would like to know your approach to teaching or training or facilitating trainees to learn public health surveillance. What recent example could you describe to help me understand?*

☐ **Communication** –stories of how the trainer prepares trainees to communicate epidemiology to different stakeholders, like decision-makers, communities, and teammates.

☐ **Epidemiologic methods** – stories on how the trainer guides trainees to design and conduct epidemiologic studies.

☐ **Courses/classes** – narratives of trainer's experience leading FETP courses or classes, like the introductory course and topic-based courses.

Interview Guide for Trainers (ADVISORS)

Learning Learning to Transform Training for Applied Epidemiology, Interview Guide – Trainer

• *Tell me about a recent class or course that you delivered. Walk me through the preparation and delivery process from beginning to end.*

• *What is a [good/frustrating] experience you have had as a trainer or facilitator?*

Late-interview questions

☐ **Mentoring** – stories of the trainer's experience as an FETP mentor. By 'mentor', we mean someone who guides the trainee, formally or informally, on field epidemiology other professional or career topics.

• *Mentoring is often discussed as a key to FETP, but we have heard many different descriptions of mentoring. What about you? Tell me about a current or important mentoring relationship in which you were the mentor.*

• *What is a [good/frustrating] experience you have had as a mentor?*

☐ **Supervising** – narratives of the trainer's experience as an FETP supervisor. By 'supervisor', we mean a person contractually assigned the professional role of supervising the trainee.

☐ **Training/learning** – stories indicating the trainer's experience with training and learning in FETP that have not been mentioned already.

• *What is the [most important/most difficult] thing that trainees need to learn in FETP? How do they learn it? What do you do to facilitate that? Bring me into your perspective.*

- *How do you assess trainees' learning? Tell me an example.*
- *Tell me about a time you benefitted from a good facilitator/trainer/mentor yourself.*
- *Give me an example in which you intervened to help a trainee who was struggling.*
- *Tell me about a [joyful/pleasant/frustrating/difficult] time you have in this programme.*
- *Tell me about a trainee who you consider having failed the programme or who did not do so well or struggled.*
- *What is the biggest change that you have seen in yourself since starting this program?*
- *In what ways does your experience in FETP differ from others? For example, in terms of gender, background, age, culture, etc., how has your experience been easier or more difficult from your colleagues?*
- *What is the bigger picture of you and this programme? How does everything you have been doing in this programme fit within a bigger picture? What are you trying to achieve?*

Post interview – Before ending the call, cover the remaining administrative issues. Keep the recording going.

☐Acknowledge that you will send a draft transcript for the interviewee's review and concurrence.

☐Remind the interviewee that no quotes will be attributed to them in published work and that we will do our best to remove identifying words from the quotes to maintain confidentiality. Explain that before using any of the interviewee's quotes in published work, we will clear them with the interviewee.

☐Clarify that interviewees can access study findings at https://tinyurl.com/FETPLearning.

☐Note that interviewees can participate in a debrief of the study findings, if interested. Ask if they are interested and note their response.

☐Say that you may contact them for a follow-up interview in the coming months.

☐Explain that some learning experiences can be unexpected, so if the interviewee feels at any point in the next couple of months that they have trained or observed learning and want to discuss it with you, the interviewee should contact you or the PI to schedule an interview.

☐Remind the interviewee that you could also do an interview after a planned event, like a course or a conference presentation or the completion of a project, so you can explore the training and learning in that event. If the interviewee is open to this, discuss timelines and dates with the interviewee to schedule a next interview. Do not pressure the interviewee to schedule now. Note that you can check back with the interviewee in a month or two, if preferred.

☐Say also that the interviewee that participation is voluntary. The interviewee can withdrawal the interview from the study at any point up until data are prepared for publication. Provide the contact information for the PI [REDACTED]. Explain that the interviewee can contact him or you at any time to remove the interview from the study.

☐Confirm that the interviewee is willing to use the interview data in the study.

- If the interviewee decides not to use the interview data, do not try to convince them. Acknowledge their response. Ask if there is anything they would like to discuss. Discuss it. Remind them of the confidentiality. Remind them that we will not attribute their words to them and that we will check with them before using any of their quotes in publications. If they would still like to withdraw from the study, thank them for their time and let them know their data will be destroyed immediately.

☐Thank the interviewee again.

☐Stop the recording.

☐ Write down any notes, reflections, thoughts, concerns, etc., including the context of the interview, the connection quality, any interruptions, the in which you and the interviewee conducted the interview, etc. Write down any observations you have about the interviewee's state of mind during the interview, any reactions you remember, when they happened, and what you thought about them. Write down also any thoughts you have about your own performance as an interviewer, what you felt you did well and what you want to improve for the next interview.

☐Store the recording and your notes in your SharePoint folder.

☐ Transcribe the recording as soon as you are able.

2nd Interview Guide for Trainees/Advisors

Prior to connecting with interviewee

☐Review your reflections of the previous interview(s) and skim the transcript to remember the topics you discussed. Note any incidents that could be explored further.

☐Review the Tips for interviewing.

☐Ensure to read and have on-hand the "Distress protocol for interviewers conducting interviews"

☐Test the microphone and speakers. Test the recording and the saving of the recording to a password-protected folder on the ANU server (i.e., your assigned folder on SharePoint).

☐Prepare and test a back-up recording device, such as a phone, in case that the participant does not want a video recording made.

Prior to starting the interview

☐Welcome the interviewee and thank him/her for agreeing to do a follow-up interview. *Note, it is a good idea to engage in chit-chat, e.g., How have you been? How is the weather there? before getting into the interview.*

☐Remind the interviewee that

1. we are conducting interviews with FETP trainers and trainees in four programs
2. the purpose of the interviews is to learn how people train and learn in FETP

☐Ask if there are any questions about the research or the interview. (See the participant information sheet to answer any questions. If you cannot answer a question, say that you will find out and get back to them. Make a note and ensure to follow up.)

☐Remind the interviewee that

1. participation is voluntary
2. interviewee can decline or withdraw at any time without explanation
3. interviewee can skip any question in the interview
4. interviewee can withdrawal the interview from the study at any point up until data are prepared for publication

☐Explain that today's interview will still focus on the interviewee's experience in the [name of FETP] and should last one to two hours. The interviewee can take a break whenever necessary.

☐Clarify that should we wish to use any of the interviewee's quotes in published material, we will check with the interviewee first to ensure confidentiality and comfort. Also explain that the interviewee does not need to worry about naming places or people because those will all be replaced with generic terms, like 'supervisor' or 'province' or 'health department' or 'trainee.'

☐ Say that you would like to [video/audio] record the interview to ensure the transcription is accurate, and that the investigators will keep the recording in a password protected file and then destroy it after analysis.

☐Start the recording.

☐Verify the recording is working.

Conducting the interview.

• **Take strategic, focused notes** to help formulate new questions, inform analysis and back up recording failures. You do not need to take verbatim notes.

• **Start with informal but impersonal questions** to establish a casual, friendly atmosphere. The flow should be natural, like a conversation between two colleagues but with one of them (you) much more interested in listening to the other.

• **Use the guide below as a list of topics that you can use to "fish" for stories.** You do not have to cover all topics in the guide within the interview.

• **Ask questions to help the interviewee narrate stories about their experience in FETP.** For example, *Tell me about a time when . . .* and *Can you describe an example of what you've just said?*

• **Use easier descriptive, less sensitive, less evaluative questions earlier and more sensitive, evaluative, and analytical questions later in the interview.**

• **Use transitions** to move between topics. Natural flow of conversation is ideal, moving from one topic to another, but it is also acceptable to change topics when you feel that one topic has been discussed enough. Examples: o *Let us change topics for a bit . . .*

o *Thank you for sharing that . . . Can we move to . . .?*

o *We have been talking about . . . Now, I would like to ask you about . . .*

o *I want to move to . . . Before we do, let me make sure I have understood what you have been saying about . . .* [Summarise.]

• **Try to interrupt as little as possible.** Let the interviewee finish thoughts before asking questions. Wait a few seconds after the interviewee finishes his or her response to allow space for the interviewee to think or add without prompting. It can help to mute your microphone so that your *hmm* and *oh* do not interrupt—this also helps the transcription.

• **Ask probing questions** to help the interviewee narrate richer stories. Probes help to follow up incomplete responses with clarifying questions. Interviewees will soon learn what degree of depth and detail you seek through probes. *Why…?* is not a good probe. Examples of good probing questions: o *Suppose I was watching this experience happen. What would I see? Take me there.*

o *Tell me more about what happened and how you were involved.*

o *What effect do you think that experience had on you?*

o *How did you prepare for that?*

o *Tell me more about your thinking at that time.*

o *I am interested in the emotional side of that experience. What were you feeling then?*

- *What did you like about . . .? What frustrated you?*
- *What opinions do you have about that now?*
- *Who or what helped you understand that?*
- *What similar experiences have you had in the past?*

Topics for interviewing

Early questions

Follow Up – early in the interview, provide a space to follow up on the previous interview.

Start with anything the interviewee wants to raise or continue to discuss from the previous interview. The key point here is to allow the interviewee to set the direction. Perhaps he or she has been wanting to share something or has been thinking about some points from the last interview to discuss further. Some questions that might help at this stage:

- *Is there anything that you have been thinking about since our interview, anything you want to share or discuss in terms of your training/learning experience in FETP?*
- *Tell me about your work since we last discussed.*
- *What memorable experiences have you had since we last discussed?*
- *What changes have occurred in you or in your FETP world since we last discussed?*
- *What new insights have you had about field epidemiology or FETP since we last discussed?*

Next, follow up on any incidents to explore further based on your notes or Matt's suggestions. These follow-ups could be key phrases that you did not catch during the interview but picked up in the transcription, recurring points that you did not explore in the first interview, concepts and generalizations that the interviewee did not narrate as a story, or points that you did not get to cover because you ran out of time. The key point here is to go deeper and to aim for narrative stories. Some questions that might help at this stage:

- *Last time we spoke, you told me about . . .. I was hoping we could revisit that and explore it a bit more. Tell me what happened.*
- *When we last spoke, you said . . .. I didn't follow up at the time, but I would like to know more about it. Could you tell me about the incident that led you to say that?*
- *During our last interview, you mentioned . . .. That seems like a really important point that we did not spend enough time discussing. Take me back to that and tell me more about the experience.*

o *Last time we spoke, you had not yet (done an outbreak investigation, started surveillance evaluation, presented at a conference, etc.). What can you share now?*

Mid-interview questions—MOST IMPORTANT!

Focused questions – these questions come from our early analyses of the data. We want to elicit interviewees' narrative experiences with these topics, especially the stories they can share. Please use the prompts below as closely as possible and then follow up with probes as appropriate. Spend time here.

1. *One interesting thing we have been finding in the data is that trainers have very different approaches to training. By 'trainers', we mean supervisors, mentors, facilitators, faculty, etc. As an example, some trainers see themselves as navigators guiding trainees in uncertain worlds, some trainers see themselves as systematic planners aiming to get trainees through a program, some see themselves as collaborators, others as an available resource with the responsibility to learn on the trainee. What has been your experience? [If there are multiple trainers, pick one or two that stand out the most]. What impact has that trainer(s) had on you?*
2. *Another interesting thing we have been finding in the data is that trainees often face the challenge of having to apply their learning in a real-world setting, which is different from the classroom. What has been your experience with that? What example can you share?*
3. *One more important topic that we've been discovering is that trainees have different experiences being able to link the courses with their work in the field. For example, some trainees see a direct benefit of a specific course like biostatistics to the work they have been doing in the field. Other trainees cannot find a useful course for the demands of the field. What about you? How have the courses in this program helped you in your work, if at all? What examples do you have?*

Late-interview questions

Training/learning – these questions were included in the first interview. Only ask them if you did not ask them in the first interview.

o *What is the [most important/most difficult] thing to learn in FETP? What did you do to learn it? How do you know you have learned it?*

o *Tell me about a [joyful/pleasant] time you have in this programme.*

o *What is the biggest change that you have seen in yourself since starting this program? Tell me about that. How did it come about?*

o *In what ways does your experience in FETP differ from others? For example, in terms of gender, background, age, culture, etc., how has your experience been easier or more difficult from others in your cohort?*

o *What is the bigger picture of you and this programme? How does everything you have been doing in this programme fit within a bigger picture? What are you trying to achieve in the long term?*

Near the end, offer the interviewee space to lead. When you feel that the interviewee is getting to the end, or at least 15 minutes before the scheduled end time, ask the following two questions:

- o *What else do you think I should ask or know?*
- o *What questions do you have for me?*

Close with a positive note. Acknowledge the contributions the interviewee has made [e.g., to the study, to the nation's health, to the country's public health system, as appropriate] or how much the interviewee has learned. Thank the interviewee. Remind the interviewee of the follow-up procedures (described in "Post interview").

Post interview – Before ending the call, cover the remaining administrative issues. Keep the recording going.

☐Acknowledge that you will send a draft transcript for the interviewee's review and concurrence.

☐Remind the interviewee that no quotes will be attributed to them in published work and that we will do our best to remove identifying words from the quotes to maintain confidentiality. Explain that before using any of the interviewee's quotes in published work, we will clear them with the interviewee.

☐Clarify that interviewees can access study findings at https://tinyurl.com/FETPLearning.

☐Note that interviewees can participate in a debrief of the study findings, if interested. Ask if they are interested and note their response.

☐Say that you may contact them for a follow-up interview in the coming months. Ask if that would be ok and note their response.

☐Explain that some learning experiences can be unexpected, so if the interviewee feels at any point in the next couple of months that they have learned something and want to discuss it with you, the interviewee should contact you or the PI to schedule an interview.

☐Remind the interviewee that you could also do an interview after a planned event, like a course or a conference presentation or the completion of a project, so you can explore the learning in that event. If the interviewee is open to this, discuss timelines and dates with the interviewee to schedule a next interview. Do not pressure the interviewee to schedule now. Note that you can check back with the interviewee in a month or two, if preferred.

☐Remind the interviewee that participation is still voluntary. The interviewee can withdrawal the interview from the study at any point up until data are prepared for publication. Provide the contact information for the PI [Redacted]. Explain that the interviewee can contact him or you at any time to remove the interview from the study.

☐Confirm that the interviewee is willing to use the interview data in the study.

• If the interviewee decides not to use the interview data, do not try to convince them. Acknowledge their response. Ask if there is anything they would like to discuss. Discuss it. Remind them of the confidentiality. Remind them that we will not attribute their words to them and that we will check with them before using any of their quotes in publications. If they would still like to withdraw from the study, thank them for their time and let them know their data will be destroyed immediately.

☐Thank the interviewee again.

☐Stop the recording.

☐Write down any notes, reflections, thoughts, concerns, etc., including the context of the interview, the connection quality, any interruptions, the in which you and the interviewee conducted the interview, etc. Write down any observations you have about the interviewee's state of mind during the interview, any reactions you remember, when they happened, and what you thought about them. Write down also any thoughts you have about your own performance as an interviewer, what you felt you did well and what you want to improve for the next interview. Save these on a word document with the suffix RFLXNS (e.g., 21_INTERVIEW_2_002_RFLXNS.docx) in your SharePoint folder. Please provide English translation of the reflections on the same document.

☐Store the recording and your notes in your SharePoint folder.

☐Transcribe the recording as soon as you are able.

3rd Interview Guide for Trainees/Advisors

Prior to connecting with interviewee

☐Review your reflections of the previous interview(s) and skim the transcript to remember the topics you discussed. Note any incidents that could be explored further.

☐Review the Tips for interviewing.

☐Ensure to read and have on-hand the "Distress protocol for interviewers conducting interviews"

☐Test the microphone and speakers. Test the recording and the saving of the recording to a password-protected folder on the ANU server (i.e., your assigned folder on SharePoint).

☐Prepare and test a back-up recording device, such as a phone, in case that the participant does not want a video recording made.

Prior to starting the interview

☐Welcome the interviewee and thank him/her for agreeing to do a follow-up interview. *Note, it is a good idea to engage in chit-chat, e.g., How have you been? How is the weather there? before getting into the interview.*

☐Remind the interviewee that

1. we are conducting interviews with FETP trainers and trainees in four programs
2. the purpose of the interviews is to learn how people train and learn in FETP

☐Ask if there are any questions about the research or the interview. (See the participant information sheet to answer any questions. If you cannot answer a question, say that you will find out and get back to them. Make a note and ensure to follow up.)

☐Remind the interviewee that

1. participation is voluntary
2. interviewee can decline or withdraw at any time without explanation
3. interviewee can skip any question in the interview
4. interviewee can withdrawal the interview from the study at any point up until data are prepared for publication

☐Explain that today's interview will still focus on the interviewee's experience in the [name of FETP] and should last one to two hours. The interviewee can take a break whenever necessary.

☐Clarify that should we wish to use any of the interviewee's quotes in published material, we will check with the interviewee first to ensure confidentiality and comfort. Also explain that the interviewee does not need to worry about naming places or people

because those will all be replaced with generic terms, like 'supervisor' or 'province' or 'health department' or 'trainee.'

☐Say that you would like to [video/audio] record the interview to ensure the transcription is accurate, and that the investigators will keep the recording in a password protected file and then destroy it after analysis.

☐Start the recording.

☐Verify the recording is working.

Conducting the interview.

• **Take strategic, focused notes** to help formulate new questions, inform analysis and back up recording failures. You do not need to take verbatim notes.

• **Start with informal but impersonal questions** to establish a casual, friendly atmosphere. The flow should be natural, like a conversation between two colleagues but with one of them (you) much more interested in listening to the other.

• **Use the guide below as a list of topics that you can use to "fish" for stories.** You do not have to cover all topics in the guide within the interview.

• **Ask questions to help the interviewee narrate stories about their experience in FETP.** For example, *Tell me about a time when . . .* and *Can you describe an example of what you've just said?*

• **Use easier descriptive, less sensitive, less evaluative questions earlier and more sensitive, evaluative, and analytical questions later in the interview.**

• **Use transitions** to move between topics. Natural flow of conversation is ideal, moving from one topic to another, but it is also acceptable to change topics when you feel that one topic has been discussed enough. Examples: o *Let us change topics for a bit . . .*

o *Thank you for sharing that . . . Can we move to . . .?*

o *We have been talking about . . . Now, I would like to ask you about . . .*

o *I want to move to . . . Before we do, let me make sure I have understood what you have been saying about . . .* [Summarise.]

• **Try to interrupt as little as possible.** Let the interviewee finish thoughts before asking questions. Wait a few seconds after the interviewee finishes his or her response to allow space for the interviewee to think or add without prompting. It can help to mute your microphone so that your *hmm* and *oh* do not interrupt—this also helps the transcription.

• **Ask probing questions** to help the interviewee narrate richer stories. Probes help to follow up incomplete responses with clarifying questions. Interviewees will soon learn what degree of depth and detail you seek through probes. *Why…?* is not a good probe. Examples of good probing questions:

o *Suppose I was watching this experience happen. What would I see? Take me there.*

- *Tell me more about what happened and how you were involved.*
- *What effect do you think that experience had on you?*
- *How did you prepare for that?*
- *Tell me more about your thinking at that time.*
- *I am interested in the emotional side of that experience. What were you feeling then?*
- *What did you like about . . .? What frustrated you?*
- *What opinions do you have about that now?*
- *Who or what helped you understand that?*
- *What similar experiences have you had in the past?*

Topics for interviewing

Early questions

Follow Up – early in the interview, provide a space to follow up on the previous interview.

Start with anything the interviewee wants to raise or continue to discuss from the previous interview. The key point here is to allow the interviewee to set the direction. Perhaps he or she has been wanting to share something or has been thinking about some points from the last interview to discuss further. Some questions that might help at this stage:

- *Is there anything that you have been thinking about since our interview, anything you want to share or discuss in terms of your training/learning experience in FETP?*
- *Tell me about your work since we last discussed.*
- *What memorable experiences have you had since we last discussed?*
- *What changes have occurred in you or in your FETP world since we last discussed?*
- *What new insights have you had about field epidemiology or FETP since we last discussed?*

Next, follow up on any incidents to explore further based on your notes or Matt's suggestions. These follow-ups could be key phrases that you did not catch during the interview but picked up in the transcription, recurring points that you did not explore in the first interview, concepts and generalizations that the interviewee did not narrate as a story, or points that you did not get to cover because you ran out of time. They key point here is to go deeper and to aim for narrative stories. Some questions that might help at this stage:

- *Last time we spoke, you told me about . . .. I was hoping we could revisit that and explore it a bit more. Tell me what happened.*

o *When we last spoke, you said . . .. I didn't follow up at the time, but I would like to know more about it. Could you tell me about the incident that led you to say that?*

o *During our last interview, you mentioned . . .. That seems like a really important point that we did not spend enough time discussing. Take me back to that and tell me more about the experience.*

o *Last time we spoke, you had not yet (done an outbreak investigation, started surveillance evaluation, presented at a conference, etc.). What can you share now?*

Mid-interview questions—MOST IMPORTANT!

Focused questions – these questions come from our early analyses of the data. We want to elicit interviewees' narrative experiences with these topics, especially the stories they can share. Please use the prompts below as closely as possible and then follow up with probes as appropriate. Spend time here.

1. *One interesting thing we have been finding in the data is that trainers have very different approaches to training. By 'trainers', we mean supervisors, mentors, facilitators, faculty, etc. As an example, some trainers see themselves as navigators guiding trainees in uncertain worlds, some trainers see themselves as systematic planners aiming to get trainees through a program, some see themselves as collaborators, others as an available resource with the responsibility to learn on the trainee. What has been your experience? [If there are multiple trainers, pick one or two that stand out the most]. What impact has that trainer(s) had on you?*
2. *Another interesting thing we have been finding in the data is that trainees often face the challenge of having to apply their learning in a real-world setting, which is different from the classroom. What has been your experience with that? What example can you share?*
3. *One more important topic that we've been discovering is that trainees have different experiences being able to link the courses with their work in the field. For example, some trainees see a direct benefit of a specific course like biostatistics to the work they have been doing in the field. Other trainees cannot find a useful course for the demands of the field. What about you? How have the courses in this program helped you in your work, if at all? What examples do you have?*

Late-interview questions

Training/learning – these questions were included in the first interview. Only ask them if you did not ask them in the first interview.

o *What is the [most important/most difficult] thing to learn in FETP? What did you do to learn it? How do you know you have learned it?*

o *Tell me about a [joyful/pleasant] time you have in this programme.*

o *What is the biggest change that you have seen in yourself since starting this program? Tell me about that. How did it come about?*

o *In what ways does your experience in FETP differ from others? For example, in terms of gender, background, age, culture, etc., how has your experience been easier or more difficult from others in your cohort?*

o *What is the bigger picture of you and this programme? How does everything you have been doing in this programme fit within a bigger picture? What are you trying to achieve in the long term?*

Near the end, offer the interviewee space to lead. When you feel that the interviewee is getting to the end, or at least 15 minutes before the scheduled end time, ask the following two questions:

o *What else do you think I should ask or know?*

o *What questions do you have for me?*

Close with a positive note. Acknowledge the contributions the interviewee has made [e.g., to the study, to the nation's health, to the country's public health system, as appropriate] or how much the interviewee has learned. Thank the interviewee. Remind the interviewee of the follow-up procedures (described in "Post interview").

Post interview – Before ending the call, cover the remaining administrative issues. Keep the recording going.

☐Acknowledge that you will send a draft transcript for the interviewee's review and concurrence.

☐Remind the interviewee that no quotes will be attributed to them in published work and that we will do our best to remove identifying words from the quotes to maintain confidentiality. Explain that before using any of the interviewee's quotes in published work, we will clear them with the interviewee.

☐Clarify that interviewees can access study findings at https://tinyurl.com/FETPLearning.

☐Note that interviewees can participate in a debrief of the study findings, if interested. Ask if they are interested and note their response.

☐Say that you may contact them for a follow-up interview in the coming months. Ask if that would be ok and note their response.

☐Explain that some learning experiences can be unexpected, so if the interviewee feels at any point in the next couple of months that they have learned something and want to discuss it with you, the interviewee should contact you or the PI to schedule an interview.

☐Remind the interviewee that you could also do an interview after a planned event, like a course or a conference presentation or the completion of a project, so you can explore the learning in that event. If the interviewee is open to this, discuss timelines and dates with the interviewee to schedule a next interview. Do not pressure the interviewee to schedule now. Note that you can check back with the interviewee in a month or two, if preferred.

☐Remind the interviewee that participation is still voluntary. The interviewee can withdrawal the interview from the study at any point up until data are prepared for

publication. Provide the contact information for the PI [Redacted]. Explain that the interviewee can contact him or you at any time to remove the interview from the study.

☐Confirm that the interviewee is willing to use the interview data in the study.

- If the interviewee decides not to use the interview data, do not try to convince them. Acknowledge their response. Ask if there is anything they would like to discuss. Discuss it. Remind them of the confidentiality. Remind them that we will not attribute their words to them and that we will check with them before using any of their quotes in publications. If they would still like to withdraw from the study, thank them for their time and let them know their data will be destroyed immediately.

☐Thank the interviewee again.

☐Stop the recording.

☐Write down any notes, reflections, thoughts, concerns, etc., including the context of the interview, the connection quality, any interruptions, the in which you and the interviewee conducted the interview, etc. Write down any observations you have about the interviewee's state of mind during the interview, any reactions you remember, when they happened, and what you thought about them. Write down also any thoughts you have about your own performance as an interviewer, what you felt you did well and what you want to improve for the next interview. Save these on a word document with the suffix RFLXNS (e.g., 21_INTERVIEW_2_002_RFLXNS.docx) in your SharePoint folder. Please provide English translation of the reflections on the same document.

☐Store the recording and your notes in your SharePoint folder.

☐Transcribe the recording as soon as you are able.

Appendix C. Presentations of Preliminary Findings

Title: Bringing the Field to the Classroom: How FETP in Asia-Pacific Leverage Situated Learning to Prepare the Health Security Workforce

Presentation (no slides) given at the Global Health Security Conference, Sydney, June 2024

1. Good morning. How should we reinforce learning in field epidemiology training programs? And what can FETP share for broader health security workforce development? I will try to answer these questions for you this morning.

2. The key point is that rather than focusing on curriculum and content, we must ensure trainees engage legitimately in the periphery of the field epidemiology community of practice. The term 'community of practice' is familiar, but most of us are not using it wrong. I will explain but first let me give you two reasons why trainees' need legitimate peripheral engagement in the community of practice.

3. First, the research: we co-designed and co-implemented a qualitative study with FETP trainers in Mongolia, Japan, Australia, and Taiwan. We conducted participant observations and interviews with twenty-seven trainers and trainees and used established qualitative analytic techniques.

4. FETP typically includes 25% didactic training and 75% field-based training. We found that field engagement and mentoring supervision are much more crucial to learning than didactic classroom training.

5. When trainees engage in real field epidemiology tasks, like creating a surveillance report or interviewing patients in a hospital outbreak, learning abounds—for technical skills, tacit understanding, and soft skills like communication. In these situations, trainees recognize what they need to

know and need to do for the task at hand and thus recognize their relevant gaps in knowledge and skill. Trainees then use self-directed learning strategies like consulting mentors, watching YouTube videos, or observing experienced field epidemiologists to fulfill their learning needs.

6. For instance, one trainee, a physician with hospital experience, deployed as an FETP trainee to a hospital outbreak investigation. His main roles were to interview staff and lead the field team under trainer supervision. Through those assigned roles, he learned that communication and team dynamics within hospitals impact infection prevention and control and thus disease transmission, and he learned that the perspectives of diverse hospital staff were crucial for determining control measures. With respect to leading, he said, *"I started by thinking about what kind of work was needed,. . .of course a trainer could have done that part by herself, but I think I was given the opportunity to learn by taking the initiative as a leader. . .In the morning and evening meetings. . ., I received many pointers and guidance. . .I felt that the trainers knew how to do it, but in a way that they did not give answers but gave me a chance to find it by myself, but if I could not find [it], they would give me guidance. . ."*

7. On the other hand, intensive classroom sessions had substantially less learning identified. Trainees described little technical learning in these sessions, and many forgot course content. Although they valued group work and simulated exercises for broadening their awareness, connecting them with colleagues, and revealing knowledge gaps, they rarely valued didactic lectures. This finding is exactly what the literature on learning tells us: delivering packets of decontextualized knowledge as though we were filling empty vessels is minimally effective for adults.

8. For example, another trainee had attended multiple sessions on data analysis but was avoiding analysing data because she felt it was a weakness. Then her supervisors assigned a project on a topic that she cared about. Through trial-and-error and supervisor consultation, she

overcame her hesitancy and built her analysis skills. When asked about the project, she said, "*I've got tons of confounding. I've got effect modification. I've got lots of things I want to look at, and my supervisor keeps going, 'No, you go that way'. And I go, 'What about this?' And [the supervisor] goes, 'No, you go that way'. . .*"

— The interviewer then said, "*I remember in the previous interview. . . you recognized that data analysis was your weakness. . .*"

— And the trainee responded, *"I'm not scared of it anymore. No way*".

9. So, we can see that learning requires self-direction, but it is the engagement in field epidemiology practice that triggers the learning process. And while the mentoring supervisors support, guide, and model effective practice, they also decide which assignments, roles, and responsibilities trainees will have. They are gatekeepers to the practice and the learning opportunities.

10. This process aligns with the theory of situated learning in communities of practice, a seminal social learning theory proposed in 1991.

11. In simple terms, a community of practice is any group of people who cohere around an enterprise, like field epidemiology, have relationships that allow mutual engagement, and share an inventory of resources that allow them to negotiate what their enterprise means.

12. Most importantly, newcomers to a community of practice, like these trainees, arrive at the periphery of the community wanting to be closer to the centre like experienced field epidemiologists. At the periphery, their tasks, like interviewing hospital staff and analysing data, are less complex with less responsibility and less risk, relative to, for instance, negotiating recommendations with hospital directors. Their tasks are peripheral, but they matter to that community of practice. So, they are legitimate.

13. As they participate in these legitimate peripheral activities, they interact with experienced field epidemiologists, observe them, ask them questions, get resources from them, and they put together what it means to be a field epidemiologist and thus what they need to be able to do to be members of the community, thereby triggering the learning process. These interactions also let trainees show capabilities to mentors and experienced community members, who can give them more complex, responsible, and risky tasks, or less peripheral ones.

14. This theory shows that engagement in practice is the mechanism and the purpose of learning. Engagement in practice means learning how to engage in practice. It means understanding what the enterprise is, what it means to be a field epidemiologist, and what tools are needed.

15. So, based on our findings and the theory of situated learning in communities of practice, we must shift our focus toward ensuring trainees' legitimate peripheral participation in the field epidemiology community of practice.

16. We can do that by 1) ensuring trainees have ample opportunities to do real work at the periphery with assignments and mentoring supervisors; 2) bringing the practice of field epidemiology into courses with local scenarios, simulations, stories, and case studies; and 3) avoiding global competencies that are overly prescriptive for meaningful participation in the national and local practice.

17. The health security sector can increase workforce preparedness by similarly adopting integrative training schemes that emphasize legitimate peripheral participation in communities of practice.

18. I look forward to hearing how our findings, interpretations, and recommendations speak to your experience.

Title: Global standards, local wisdom—An exploration of learning among epidemic-investigator training programs

Presentation given at the ANZAHPE 2024 Conference, Adelaide, July 2024

Matthew Myers Griffith, Emma Field, Angela Song-en Huang, Tomoe Shimada, Munkhzul Battsend, Tambri Housen, Barbara Pamphilon, Martyn Kirk

GLOBAL STANDARDS, LOCAL WISDOM

An exploration of learning among epidemic-investigator training programs

Matthew Myers Griffith, Emma Field, Angela Song-en Huang, Tomoe Shimada, Munkhzul Battsend, Tambri Housen, Barbara Pamphilon, Martyn Kirk

FETP: post-graduate training in field epidemiology

- 9 – 24 months
- 25% didactic / 75% field-based
- Graduates in government and NGOs
- Graduates investigate outbreaks, lead public health

Langmuir and the Polio Surveillance Unit at the EIS in 1955. Source: Lamelli, V. for Vaccopedia.org (2018)

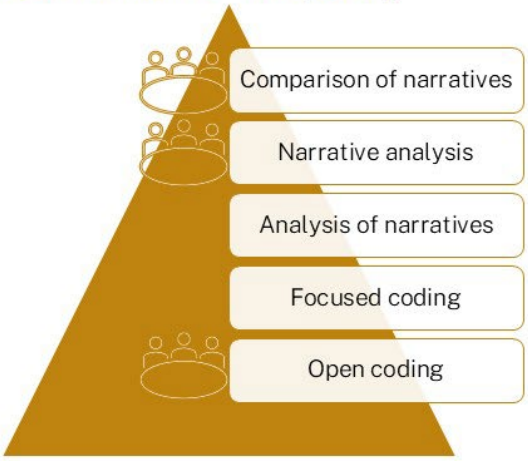
FETP today: 100 programs, 200 countries

- 1951 US CDC Epidemic Intelligence Service (EIS)
- 1975 Canada FETP
- 1980s Thailand, Philippines, Indonesia, Saudi Arabia, Mexico
- Standardized curricula
- Global accrediting body

How do field epidemiologists learn in FETP?

- Co-designed and co-implemented with lead trainers from FETP Australia, Japan, Mongolia, Taiwan
- Participant observations (15 days, 3 programs)
- Unstructured interviews (n=47) with trainers (n=6) and trainees (n=21)
- Situated in Charmaz's (2014) constructivist grounded theory and Polkinghorne's (1988;1995) narrative inquiry
- Protocol published in BMJ Open (2024) Griffith et al.

Analyzed with Grounded Theory and Narrative Inquiry



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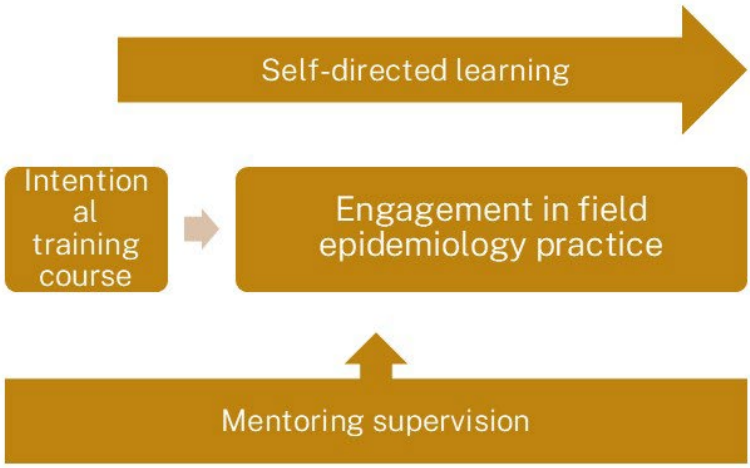
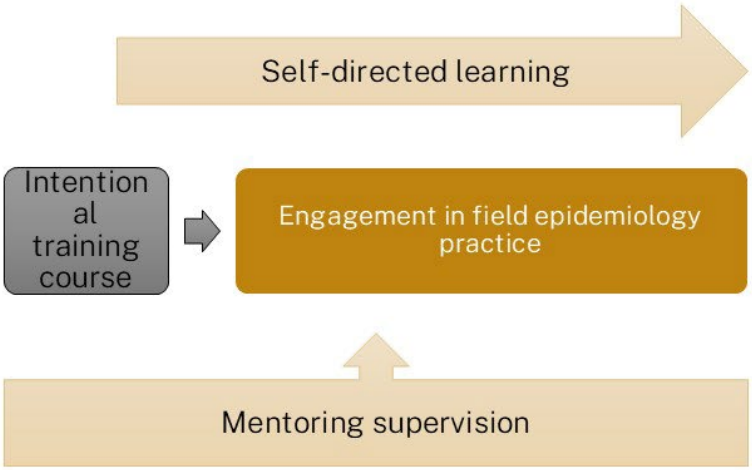
A shared a learning process across programs



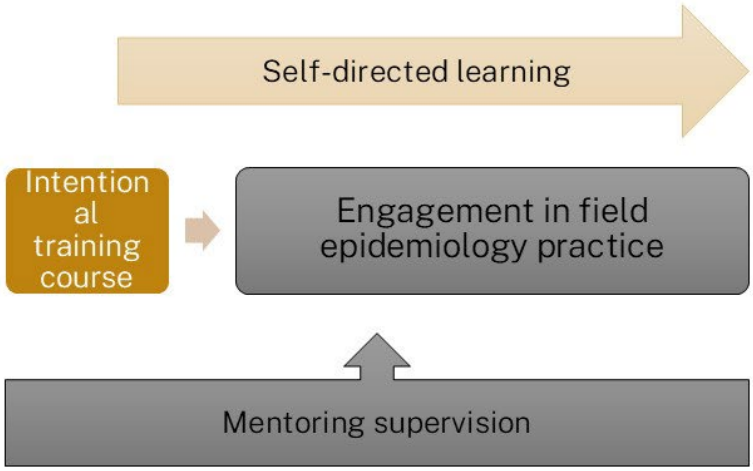
Abundant learning in practice: technical, tacit, soft



Outbreak investigation, interactions with hospital staff, and supervisors

Trainee on leading outbreak investigation: *"I think I was given the opportunity to learn by taking the initiative as a leader. . .they did not give answers but gave me a chance to find it by myself, but if I could not find [it] they would give me guidance. . ."*

Little technical learning in courses



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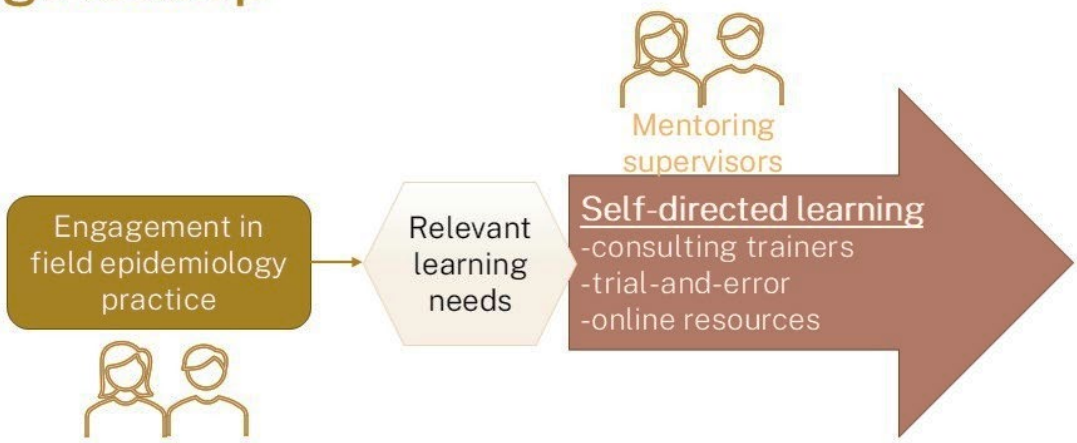
Hesitant until assigned a study, then trial-and-error, supervisor consultations

Interviewer: *"I remember in the previous interview. . . you recognized that data analysis was your weakness. . ."*

Trainee: *"I'm not scared of it anymore. No way".*

Mentoring supervisors support, model, gatekeep



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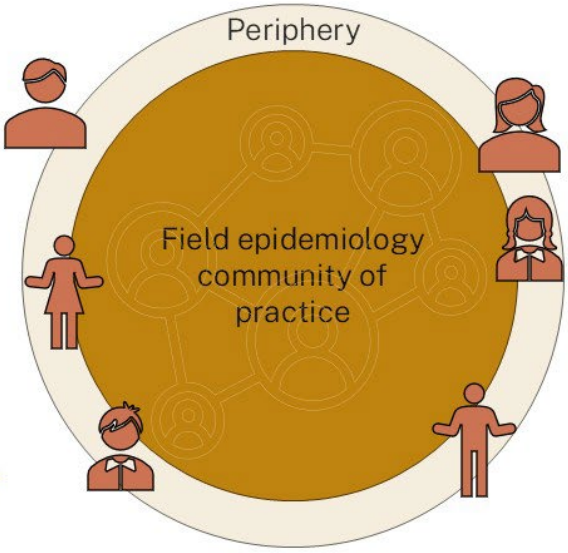
Situated learning in communities of practice

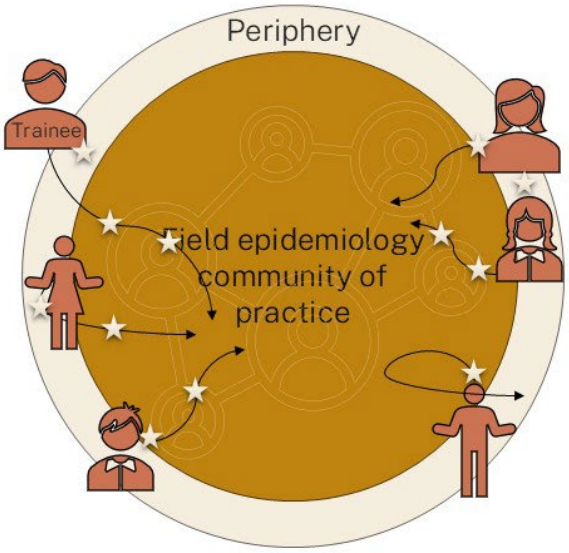
- Joint enterprise
- Mutual engagement
- Shared repertoire

Newcomers arrive at the periphery wanting to be members

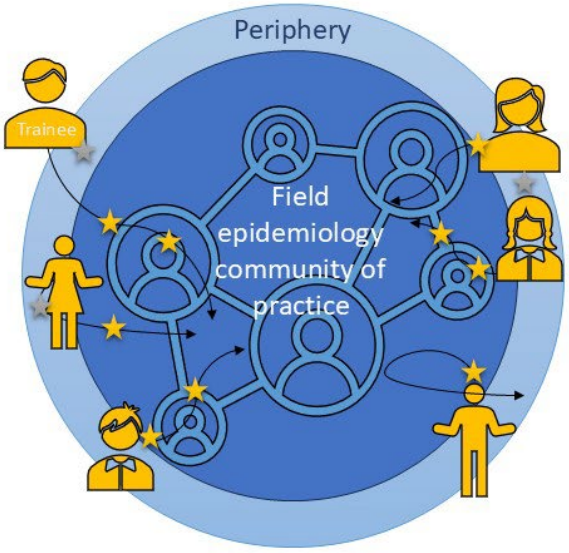


Situated learning in communities of practice. Lave and Wenger (1991); Wenger (1998).

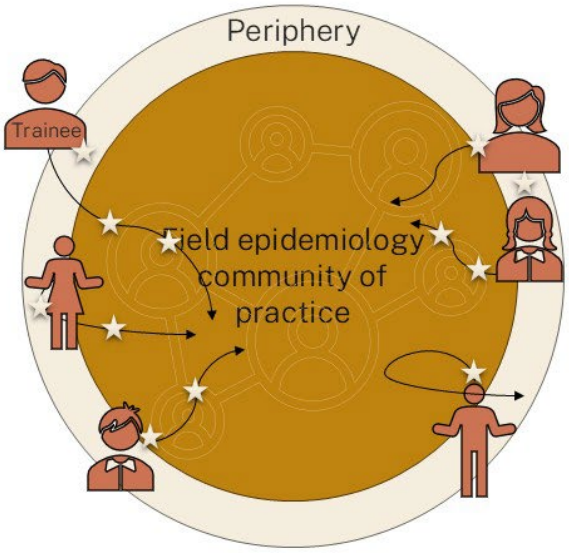
Engagement in practice is the purpose and the mechanism



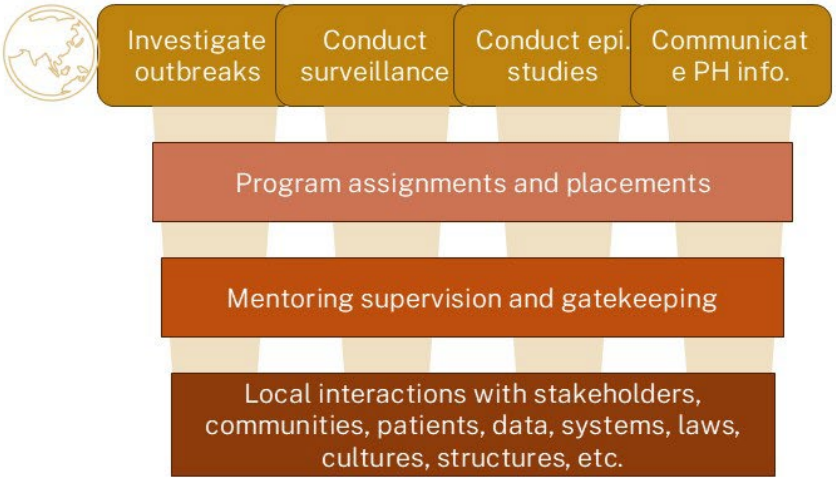
Engagement in practice is the learning mechanism and purpose



Didactic training lacks participation in practice



Resolving tension between global standards and local learning



Take home messages

- Practical engagement and mentoring are crucial for FETP learning, more than didactic methods
- Bring the field into the classroom through scenarios, simulations, stories, and case studies
- Ensure global core activities allow for engagement in national and local contexts

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Script

1. Good afternoon. Today I will describe a study we are conducting on learning in field epidemiology training programs and share some preliminary findings. I hope to hear your questions and advice especially on two aspects: the method and the applicability of these findings to other settings.

2. Field epidemiology training programs or FETP began in 1951 in the US. It aimed to train medical doctors as epidemiologists, and it recruited white males, mostly physicians but a few statisticians and sanitary engineers. In the 1980s, programs appeared in Asia driven by US CDC, which provided funding and a resident advisor who would spend five years in a country setting up and guiding the program.

3. Today, almost 100 FETP are training in 200 countries and territories, mostly in ministries of health, with a few in universities. They embrace what they call 'learning by doing' and typically involve 25% didactic training and 75% mentored field training. Programs run 9–24 months. Graduates have investigated the world's epidemics and become national and global public health leaders. So, we wondered how this program's training approach has helped it to endure for more than 70 years, run in diverse contexts, and produce public health leaders. Specifically, we wondered how they continued to address global training standards in so many localized contexts. Nobody had looked at this program from an educational perspective.

4. I came to this research from a constructivist and critical perspective, as my first enchantment with formal pedagogy came through Paolo Freire. It was important that the process align with principles of community-based participatory research. The community, from my perspective, is the trainers, the educators. They have more investment and power in these programs than trainees. So, I engaged leading trainers of seven programs. Six agreed to take part and then two dropped out for administrative reasons. So, we have co-designed and implemented this study with trainers in Mongolia, Japan, Australia, and Taiwan.

   — Initially, I met with these co-researchers monthly, where we discussed their programs, questions, and needs. As part of the background of my thesis, I conducted a case study with Barbara Pamphilon at the University of Canberra on the first FETP. I used that work

as an opportunity to share several learning theories in the context of FETP with the co-researchers.

— With respect to the case study, I will briefly say that we found *surprisingly* that the program aligned well with the theories of Knowles, Kolb, and Lave and Wenger, which suggested that this 1950s American medical institution program was using constructivist pedagogy. We published that case study in the *Journal of Lifelong Learning* earlier this year.

— Next, I outlined the overall research framework and brought it to the co-researchers. After review and discussion, I developed a protocol and again shared it for input. We have published the protocol in BMJ Open this year.

5. About the method, we conducted participant observations in three programs and forty-seven interviews with twenty-seven trainers and trainees. We interviewed in the language of the program and then transcribed, shared with the interviewee for concurrence, and then translated into English for analysis. Interviews were unstructured and aimed at participants' stories. We had back-up prompts for major training contexts, like outbreak investigation, surveillance system evaluation, and the introductory course.

6. I began analysis following Charmaz's constructivist grounded theory, which is to start with open coding. According to grounded theory, data collection and analysis are concurrent. So, I brought codes, sections of deidentified interview transcripts, and coding frameworks to the co-researchers and facilitated discussions about them. Our discussions directed further coding and interviewing. For example, the co-researchers wanted to look at the introductory course separately from the rest of the training program because it was intentional training in a controlled environment and because they invested heavily in designing and delivering the introductory courses.

— The second level of analysis in Charmaz's grounded theory is focused coding. Here, we brought in Polkinghorne's narrative inquiry. I coded larger sections of data to denote when the interviewees were narrating or storying. This shifted my perspective. It helped me to separate generalized responses from specific responses. A generalized response is, for example, when someone says, "I always ask questions when I am confused". A specific response is, "I stumbled through my data analysis project and brought as many questions to my supervisors as I could fit into our 45-minute fortnightly meetings". Compared to generalized responses, stories—that is, chronological sequences of events told in past tense about an identifiable situation—included evidence of the points that interviewees were making and revealed the meaning of the events for the interviewees.

— The next step was to do what Polkinghorne calls 'analysis of narratives'. I looked at the stories and identified their context, for example introductory course or outbreak investigation; their main action or movement, such as a change in the narrator's understanding or skill; the supporting characters who helped or impacted the narrator or situation; and what was learned or not learned.

— I then followed Polkinghorne's 'narrative analysis' for each program. I synthesized the stories by context and created an overall narrative for each program, essentially a case story for how training and learning happens in each program. I sent these deidentified to the respective trainer among the co-researchers and asked them about verisimilitude and other observations. Now we are looking across the case stories for similarities and differences.

7. So, what do we see? All four programs share a learning process that incorporates three elements: 1) trainees' self-directed learning; 2) mentoring supervision; and 3) a training structure that engages trainees in field epidemiology practice. [Structured learning]

8. The programs' training structure begins with an introductory course followed by real-world assignments and routine work, such as evaluating surveillance systems, monitoring disease reports, conducting prevention activities, and investigating outbreaks.

    — In the introductory course, trainees value the group work and simulated exercises for broadening their public health awareness, connecting them with colleagues, and revealing knowledge gaps, but they rarely appreciated didactic lectures. Moreover, they reported little technical learning in these courses. Many forgot course content. Some engaged in self-directed learning, but mostly that occurred after the course when real-world situations required them to have it.

    — So, one key finding is that real-world application of course material was more crucial for learning than the introductory course itself. Real situations requiring course content triggered trainees' self-directed learning processes.

9. In contrast, real-world assignments, including routine placement work, overflowed with learning, including technical skills, tacit understanding, and soft skills like communication and leadership.

    — For instance, one trainee initially avoided data analysis due to a perceived weakness for it well after the introductory course, but assigned epidemiological study forced her through trial-and-error and supervisor guidance to overcome her fear and build her skills. She said about the study, "*I've got tons of confounding. I've got effect modification. I've got lots of things I want to look at, and my supervisor keeps going, 'No, you go that way'. And I go, 'What about this?' And [the supervisor] goes, 'No, you go that way'. . .*"

— The interviewer said, "*I remember in the previous interview. . . you recognized that data analysis was your weakness. . .*"

— And the trainee responded, *"I'm not scared of it anymore. No way*".

— Another trainee, who was a medical doctor with much hospital experience deployed as an FETP trainee for an outbreak investigation in a hospital. His main roles were to interview staff and lead the field team under trainer supervision. Through that experience, he learned that communication and team dynamics within hospitals impact infection prevention and control and thus disease transmission, and he learned that perspectives of diverse hospital staff are crucial for deciding control measures. With respect to leading, he said, "*I started by thinking about what kind of work was needed, so—of course a trainer could have done that part by herself, but I think I was given the opportunity to learn by taking the initiative as a leader. I received a lot of guidance during the preparation stage. In the morning and evening meetings. . ., I received many pointers and guidance. . .I felt that the trainers knew how to do it, but in a way that they did not give answers but gave me a chance to find it by myself, but if I could not find [it], they would give me guidance. . .*"

10. This is our second major finding. Engagement in practice, with real data, people, and situations, surfaced learning needs relevant to the task at hand. Trainees then used self-directed learning strategies like consulting trainers, trial-and-error, reading, or observing senior practitioners to meet those needs. Their learning required self-direction and interaction with others, particularly their mentoring supervisors.

— These mentoring supervisors do not only play a supportive role. They are the ones who decide which assignments trainees have, what roles they play, and how much responsibility they take on. They are a kind of gatekeeper in addition to a mentor and supervisor.

11. So, what does this mean? Jean Lave and Etienne Wenger's 1991 theory of situated learning in communities of practice helps to explain these findings. For them, newcomers to a community of practice learn through *legitimate peripheral participation*, which is engagement in real practice at the periphery of the community, where tasks are less complex and carry less responsibility and risk. Newcomers want to become full members of

the community of practice, so they seek out opportunities to identify what is needed for full membership and to develop and prove their capabilities.

— Here, the community is the experienced field epidemiologists. Trainees are newcomers who want to become field epidemiologists. Their goal drives them to engage at the periphery so that they can prove their knowledge and skill and thus engage in more advanced practice with more responsibility. Their learning occurs as they interact with members, artefacts, and activities of the community of practice.

— In 1998, Wenger added to the theory, emphasizing that engagement in practice is both the mechanism and the purpose of learning because engagement in practice means learning how to engage in practice. It means defining identities, understanding the enterprise, and adopting tools for practice.

— From this theoretical view, we can further understand of two key points. First, introductory courses, especially didactic lectures that are abstract from practice, are less effective because they are not the practice. They talk *about* the practice and the tools for that practice, but trainees have yet to experience the practice. They do not know what they need to know or how to use it.

— Engagement in the practice, however, forces trainees to acknowledge their needs for engaging appropriately. This is what we see in the data: trainees realized they needed specific technical skills and tacit knowledge to apply in context. They needed communication approaches, understanding of which relationships to build or avoid and how and which leadership styles are suitable, which they identify and learn in practice. In a study like ours, Taber and colleagues (2008) found that emergency responders gain expertise more through implicit, informal experience than through formal training. Their case study supports Lave and Wenger's description of learning as becoming part of a community of practice, engaging tacit and explicit dimensions of social practice.

12. Second, the interplay of structured engagement in practice and mentoring supervision could be how FETP retains global standards to define it as a discipline while leveraging local wisdom to educate trainees. Engagement in practice is always local. It means interacting with local public health officials, community stakeholders, hospital patients, data, surveillance systems, etc. Trainees learn through those interactions, as we showed in the last slide. We also showed how mentors not only support and guide trainees in these interactions, they serve as gatekeepers, deciding which and how much engagement will happen. The program chooses assignments for trainees, and these are likely to be based on the national or local context. They choose assignments in line with what the global community determines are the core activities of field epidemiology.

    — This means that the core activities must not be too prescriptive so they can accommodate national contexts. It means assignments matter and mentoring supervision and gatekeeping matter, too, for linking global and local.

13. In conclusion, field epidemiologists do learn by doing, a self-directed learning, but that means engaging in practice, and engagement in practice is planned, controlled, and supported by FETP, especially through the trainers and mentors. Engagement helps trainees to realize their learning needs, which require self-directedness, persistence, and perseverance, to fulfill. This learning process also clarifies how globally standard activities of practice can be met by leveraging local wisdom. Our next step is to investigate the contextual differences in these programs to understand what they mean for training and learning.

Title: Global Standards, Local Wisdom—An exploration of learning among epidemic-investigator training programs

Matthew Myers Griffith, Emma Field, Angela Song-en Huang, Tomoe Shimada, Munkhzul Battsend, Tambri Housen, Barbara Pamphilon, Martyn Kirk

Presentation given at the XVIII World Congress of Comparative Education Societies, Ithaca (USA), August 2024

FETP: post-graduate training in field epidemiology

- 9 – 24 months
- 25% didactic / 75% field-based
- Mentored supervision
- Alumni in government and NGOs
- Alumni investigate outbreaks, lead public health

Langmuir and the Polio Surveillance Unit at the EIS in 1955. Source: Lammelli, V. for Vaccopedia.org (2018)

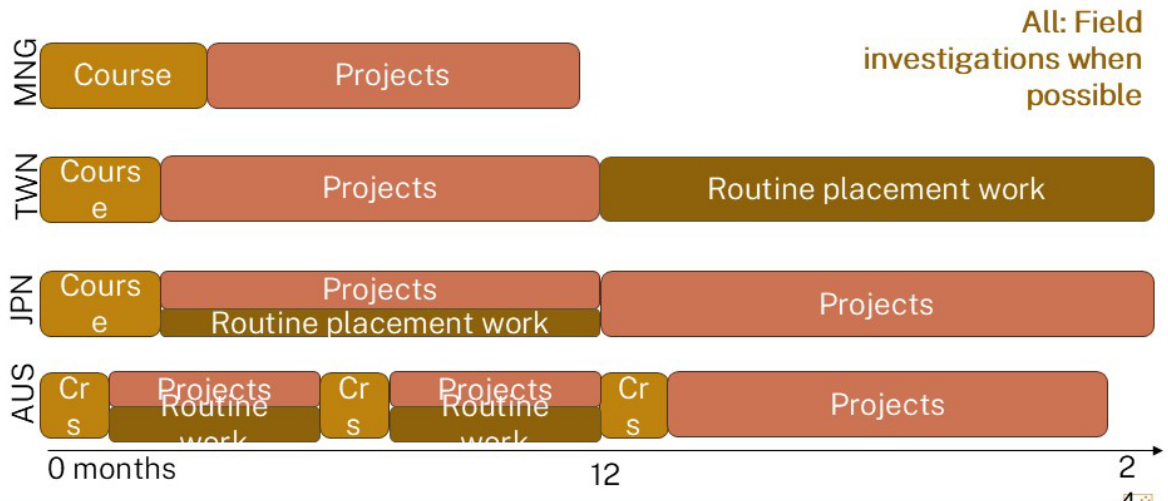
FETP today: 100 programs, 200 countries

- 1951 US CDC Epidemic Intelligence Service (EIS)
- 1975 Canada FETP
- 1980s Thailand, Philippines, Indonesia, Saudi Arabia, Mexico
- Standardized curricula
- Global accrediting body

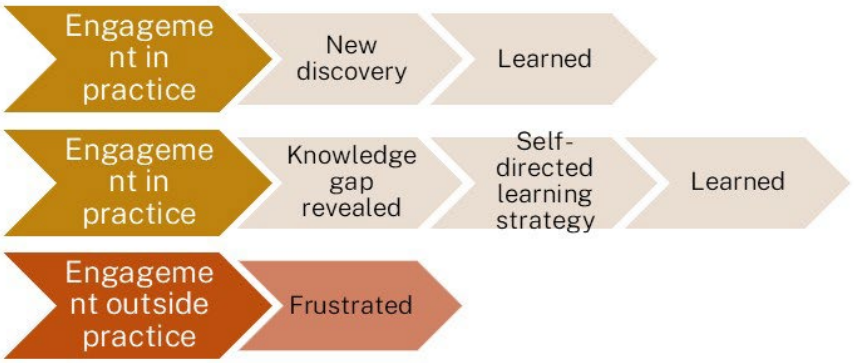
How do field epidemiologists learn in FETP?

- Co-designed and co-implemented with lead trainers from FETP Australia, Japan, Mongolia, Taiwan
- Participant observations (15 days, 3 programs)
- Unstructured interviews (n=47) with trainers (n=6) and trainees (n=21)
- Situated in Charmaz's (2014) constructivist grounded theory and Polkinghorne's (1988;1995) narrative inquiry
- Protocol published in BMJ Open (2024) Griffith et al.

Programs share learning situations



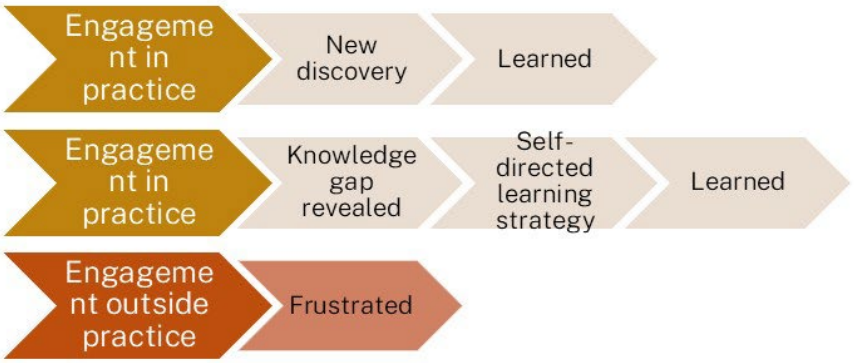
Programs and learning environments share a common learning process



Programs and learning environments share a common learning process

Trainee: *"I heard from the nurses on site that although the nurses and others on site were working very hard, the director and physicians were not really responding. (short pause) [My field supervisor] said something like, '[FETP] conducts field investigations and speaks for the infection control staff and nurses, what they want to tell the director, what they want to see done. It is one of our roles to facilitate smooth communication'. I thought the supervisor is right. I think one of the most important things I learned from this was that there is such a thing, that we go for that purpose."*

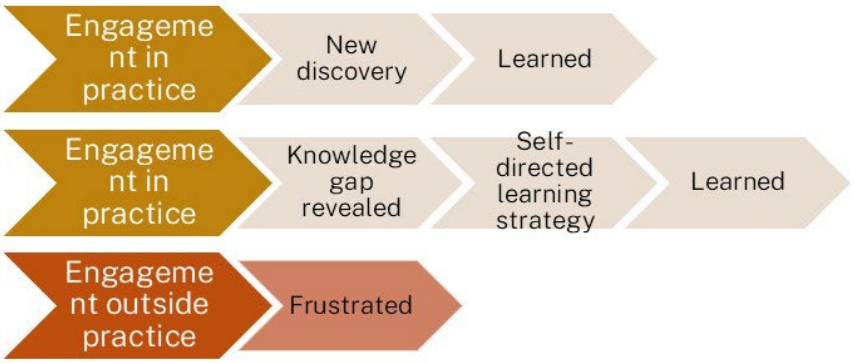
Programs and learning environments share a common learning process



Programs and learning environments share a common learning process

Trainee: *"We don't have much lessons about the evaluation of surveillance systems, and I feel quite ambiguous—like not clear about the how to do the evaluation. And then now come to my project. Yeah, it's like totally new thing for me to learn how to do it. . .So, I have the solution, for me, is that I have to read a lot of publications from on PubMed, from different sources on the internet and I learn the way they write the publication, the way they evaluate the system in their country. And I know that each country has different surveillance system. . .So, the other countries, they also have similar surveillance, a similar evaluation. So, I learn from this, mostly from the journal article."*

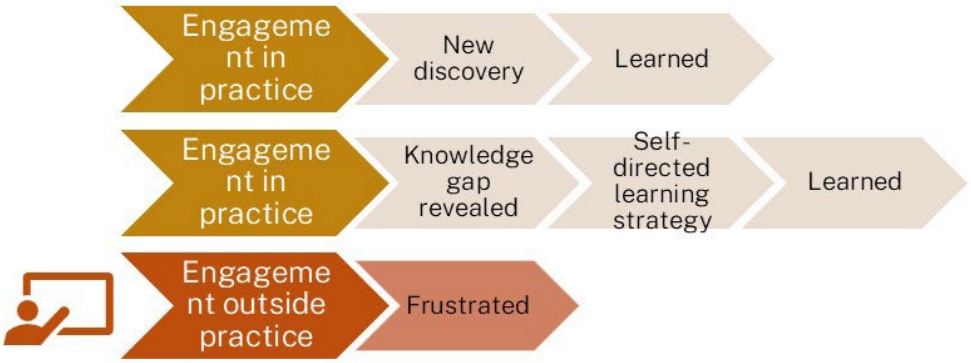
Programs and learning environments share a common learning process



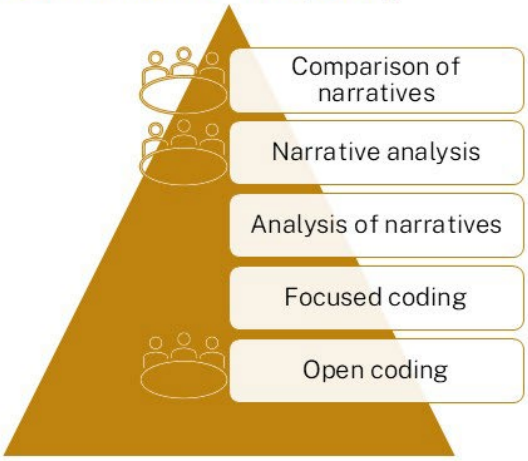
Programs and learning environments share a common learning process

Trainee: *"I have no idea what's going on [in the peer learning grou]. Um, but then I think, I think the last couple months, just because I've been doing more project stuff and [my R skills are] not up to the level where I'm writing the code, and so I think it's just like dropped off and like motivation, like I'd have to be motivated to do it. And so, I've just been so—I haven't touched it for a long time. . ."*

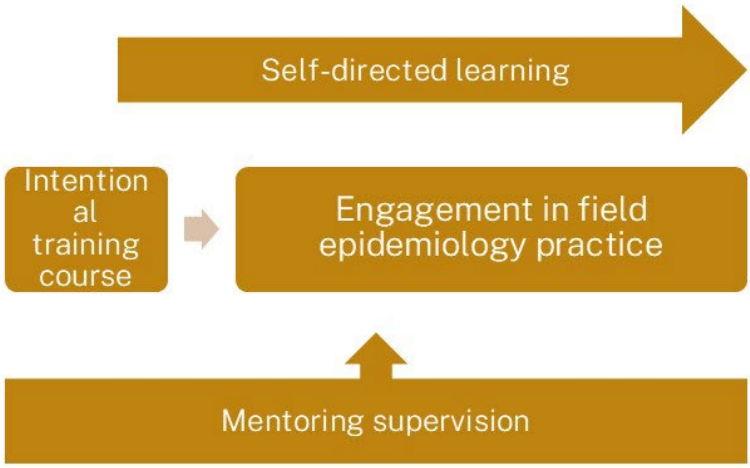
Programs and learning environments share a common learning process



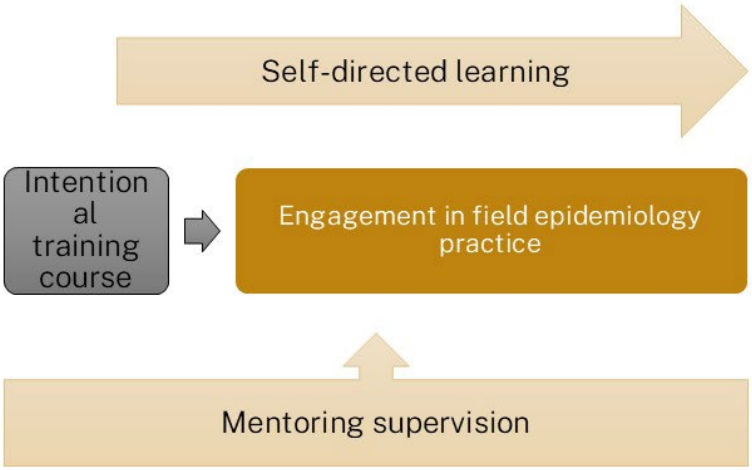
Analyzed with Grounded Theory and Narrative Inquiry



A shared a learning process across programs



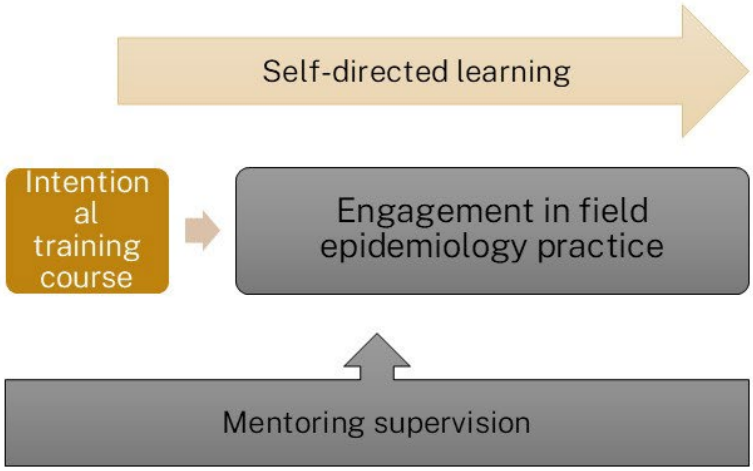
Abundant learning in practice: technical, tacit, soft



Outbreak investigation, interactions with hospital staff, and supervisors

Trainee on leading outbreak investigation: *"I think I was given the opportunity to learn by taking the initiative as a leader. . .they did not give answers but gave me a chance to find it by myself, but if I could not find [it] they would give me guidance. . ."*

Little technical learning in courses



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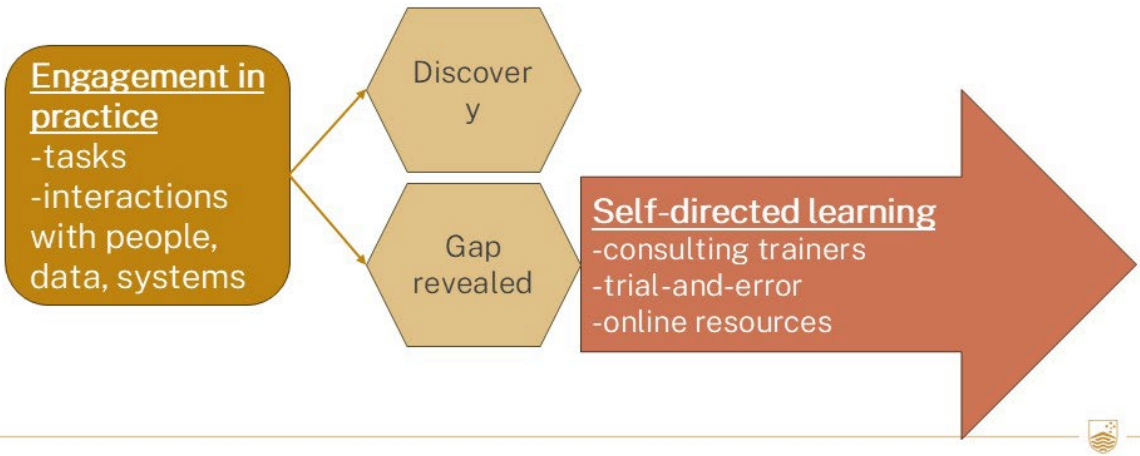
Trainee project used trial-and-error and supervisor consultations

Trainee: *"I've got lots of things I want to look at [in the data], and my supervisor keeps going, 'No, you go that way'. And I go, 'What about this?' And [the supervisor] goes, 'No, you go that way'. . ."*

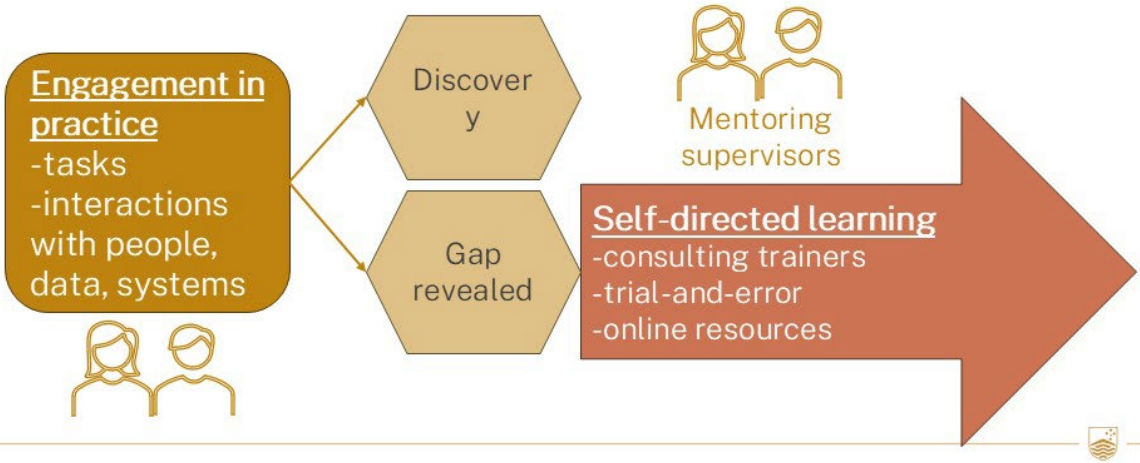
Interviewer: *"I remember in the previous interview. . . you recognized that data analysis was your weakness. . ."*

Trainee: *"I'm not scared of it anymore. No way".*

Engagement in practice triggers a better learning outcome



Mentoring supervisors are crucial to the learning process



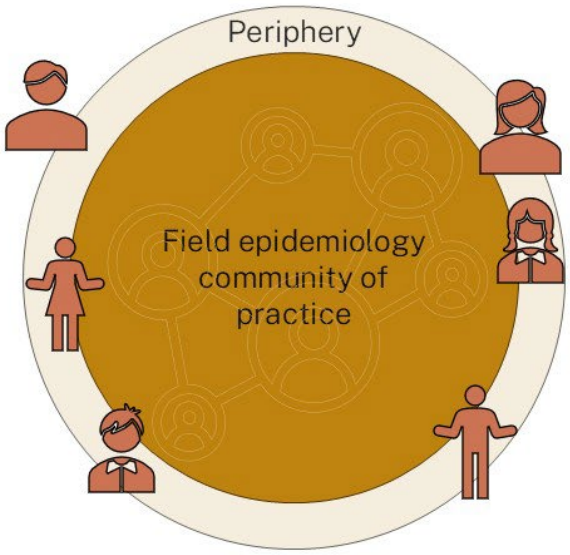
Situated learning in communities of practice

- Joint enterprise
- Mutual engagement
- Shared repertoire

Learning process aligns with multiple theories

- Vygotsky (1999; 1978): learning through social interactions, ZPD (mentoring supervisors)
- Knowles (1989): assumptions of andragogy (self-concept, readiness to learn, problem-centered, intrinsic motivation)
- Kolb (2014; 1984): experiential learning cycle on experience, experiment (reflection with conceptualizations)
- Lave & Wenger (1991), Wenger (1998): situated learning in

Newcomers arrive at the periphery wanting to be members



Situated learning in communities of practice.
Lave and Wenger (1991); Wenger (1998).

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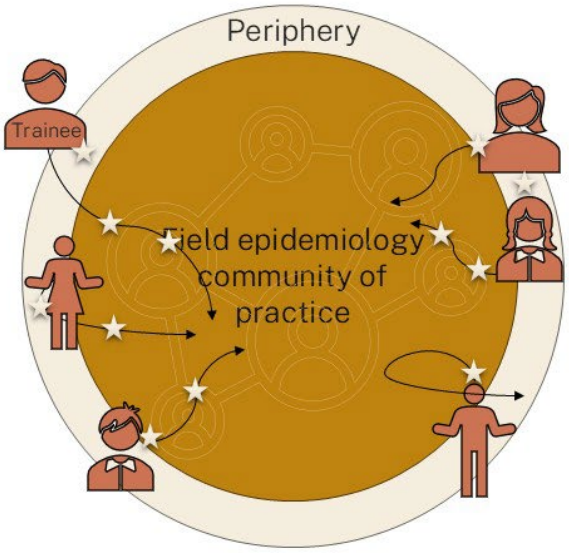
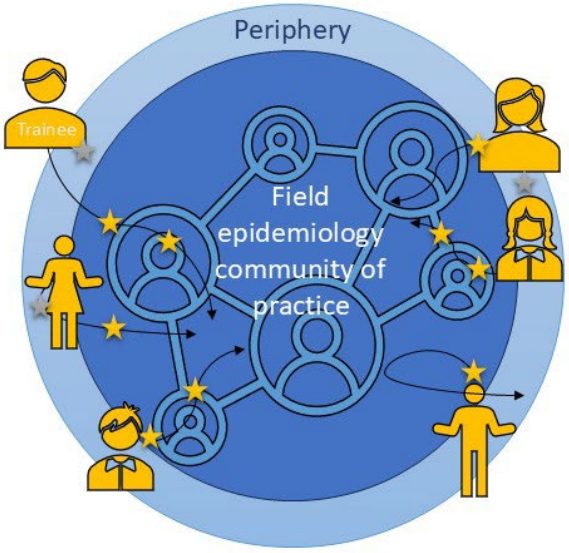
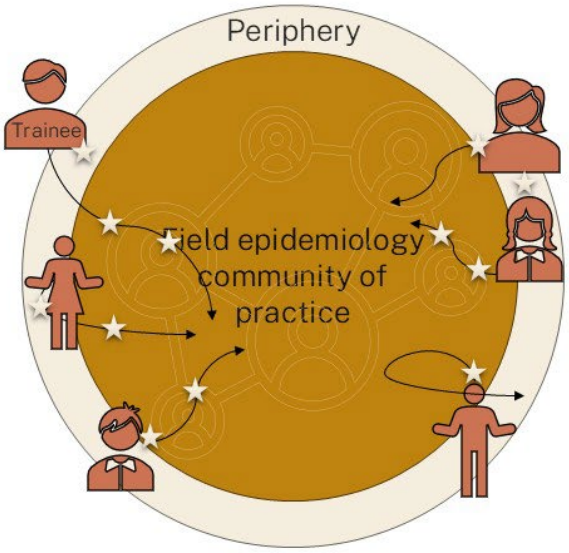
Engagement in practice is the purpose and the mechanism



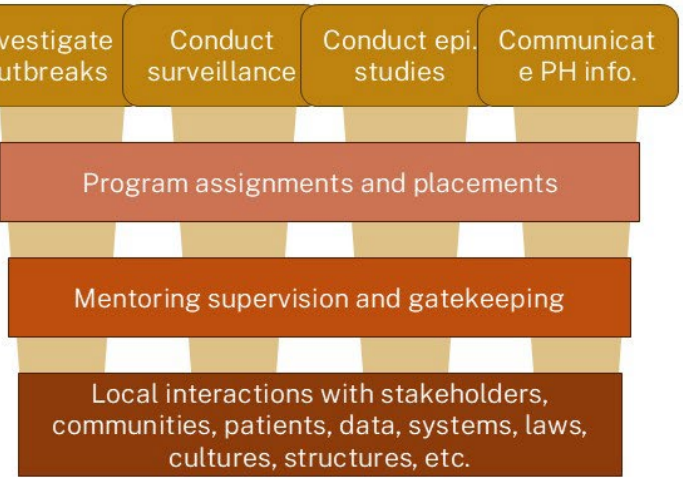
Engagement in practice is the learning mechanism and purpose



Didactic training lacks participation in practice



Practice (learning) is local for global competencies



Take home messages

- Practical engagement and mentoring are crucial for FETP learning, more than didactic methods
- Bring the field into the classroom through scenarios, simulations, stories, and case studies
- Ensure global core activities allow for engagement in national and local contexts

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Script

1. Good afternoon. I want to start by bringing you into my world so that you may understand why I'm doing this research and how it might be helpful to you and so that you can advise me how to do it better.

2. The image you see here is in Cambodia. The woman on the left is a field epidemiologist. Thanks to COVID, I may not need to explain what an

epidemiologist is. She is in a market. She is asking questions of people who work in the market, and she is checking this woman's vaccination status. She is investigating an epidemic. That is mostly what field epidemiologists are known for. They go into communities and hospitals and long-term care facilities and restaurants, and they find out why a disease is spreading and then make recommendations to stop it.

— To do this job, they need to understand bacteria and viruses and how they infect people. They need to use statistics, conduct surveys, manage and clean data. They need to conduct studies rapidly with little information nor time. But they also need to communicate with people, to build trust with this woman here, who is handing over her identification that says whether she's vaccinated. That kind of trust must be built with hospital directors and diverse ethnic groups. They need trust so that they can ask questions and get honest answers. So, how could she learn all these skills?

3. Field epidemiologists learn mostly through field epidemiology training programs, or FETP. These post-graduate programs train health professionals with 25% didactic and 75% field-based approaches. They use a mentoring style of supervision. Graduates tend to work in government or NGOS investigating the world's epidemics. Many become public health leaders.

4. FETP began in the United States in 1951 with 22 white male physicians and 1 white male sanitary engineer. Since then, the US Centers for Disease Control and Prevention has been the main force spreading FETP around the globe—replicating its model with funding, curricula, and resident advisors. Today, 100 FETP operate in 200 countries and territories, primarily within ministries of health but also in universities.

— As FETP spread across the globe, standardized curricula were developed. Accreditation bodies formed. This situation raised questions for us, like how this program endured for more than 70 years, how it was able to set

roots in so many diverse contexts and cultivate public health leaders, how it balances learning scientific technical knowledge with practical application in diverse contexts, and how it addresses the tension between global standards and local learning. Since no one had answered these questions, we set out to do so, starting with the simple question: How does learning happen in FETP?

5. We co-designed and co-implemented a study with FETP trainers in Australia, Japan, Mongolia, and Taiwan. We conducted participant observations and interviews, and we used established qualitative research methods to analyse and interpret the data. So, what do we see?

6. All four programs have similar learning situations: an intensive classroom course, projects, routine placement work (except Mongolia), and field investigations. The courses are classroom based, last four to eight weeks, sometimes all at once, sometimes in blocks. They focus on core knowledge: statistics, disease transmission, research methods, and surveillance. Routine work occurs in their field placements either at the national or a provincial or local health department, and it includes monitoring diseases, conducting risk assessments, following up on unusual cases or clusters, participating in lots of meetings, and conducting field visits for example to a restaurant with the health inspector or to a mosquito sampling site to count mosquitoes and send them for virus testing. Then they have projects that they need to complete to graduate, which include epidemiological studies, analysis of surveillance data, and evaluations of public health programs, especially public health surveillance. They also go on outbreak investigations when they arise.

7. Across these situations, we found common learning processes. In the first, trainees engage in tasks, and they discover something they did not previously know. [CLICK] For example, one trainee was on an outbreak investigation interviewing hospital nurses. The nurses told her that the medical doctors did not listen to the nurses about following infection

prevention and control procedures. When the trainee told her field supervisor, he said that part of the field epidemiologist's role was to use investigation findings to advocate for the nurses' voice in the hospital and smooth out communication to prevent disease transmission. She had never thought of that role: it was surprising yet sensible knowledge that she learned. [CLICK]

— In the second process, which was the most often described, trainees engage in some task and encounter gaps in their knowledge relevant to the situation. Then, they use self-directed strategies to fill these gaps. [CLICK] For example, one trainee was evaluating a surveillance system and following the guidelines, but she could not fit her situation into the guidelines. So, she read dozens of published articles about similar evaluations; she summarized them; and she brought her summary and questions to her supervisors. She then used this knowledge to complete her project. During the interview she noted that the process had taught her not only surveillance evaluation but that every surveillance system was unique and needed to be evaluated differently. [CLICK]

— Lastly, we found that the processes that most often led to failed or frustrated learning were the ones in which the trainee was engaged in learning just for the sake of it. [CLICK] For instance, one trainee wanted to learn R, a data analysis software, because she had heard that it was the future of epidemiology. She tried on her own for a few months, joined online groups, consulted peers, viewed tutorials, but she was not progressing. Finally, she gave up because none of her projects or tasks required R. She had no motivation to continue, she said. [CLICK]

— This last situation was what we saw most often in the courses. Trainees described little technical learning, and many forgot course content. They struggled to retain information or to know what information mattered during these courses, especially lectures. They felt overwhelmed, frustrated, and wondered why they needed such information.

— What seems important then, is that trainees have a task with some real purpose. They want to contribute to the public's health or to their workplace or they want to be recognized as competent researchers and outbreak investigators. They want to find the answer to the problem. They want to provide answers to the community.

8. To illustrate, another trainee had attended multiple classroom sessions on data analysis but was avoiding analysing data because she felt it was a weakness. Then her supervisors assigned her a project to analyse trends among people with repeated gonorrhoea infections. She felt that was a serious public health problem, a failure of health education. So, through trial-and-error and supervisor consultations, she overcame her hesitancy and built her analysis skills. When we asked about the project, she said, "*I've got lots of things I want to look at [in the data], and my supervisor keeps going, 'No, you go that way'. And I go, 'What about this?' And [the supervisor] goes, 'No, you go that way'. . .*"

— The interviewer then said, "*I remember in the previous interview. . . you recognized that data analysis was your weakness. . .*"

— And the trainee responded, *"I'm not scared of it anymore. No way*."

9. So, we see that engagement in real practice matters. Self-direction matters.

10. And the mentoring supervisors matter. They support, guide, and model effective practice, and they decide which assignments, roles, and responsibilities trainees will have. They act like gatekeepers to the field and therefore learning opportunities.

11. Multiple theories support these findings, some of which I have listed here. I want to focus on the last one today.

12. In simple terms, a community of practice is any group of people who cohere around an enterprise like field epidemiology, have relationships that allow mutual engagement, and share a repertoire of resources that allow them to negotiate what their enterprise means.

— Newcomers to a community of practice, like our trainees, arrive at the periphery of the community wanting to be closer to the centre like experienced field epidemiologists. At the periphery, their tasks, like interviewing hospital staff and analysing data, are less complex with less responsibility and less risk, relative to, for instance, leading an investigation or negotiating recommendations with hospital directors. Their tasks are peripheral, but they matter to that community of practice. So, they are legitimate. The peripherality matters too because messing up an outbreak investigation could mean that more people die.

13. As they participate in these legitimate peripheral activities, they interact with experienced field epidemiologists, observe them, ask them questions, get resources from them, and they put together what it means to be a field epidemiologist and thus what they need to be able to do to be members of the community, thereby triggering the learning process. These interactions also let trainees show capabilities to mentors and experienced community members, who can give them more complex, responsible, and risky tasks, or less peripheral ones.

— So, engagement in practice is the mechanism and the purpose of learning. It means learning how to engage in practice and understanding what the practice is—what it means to be a field epidemiologist and what tools are needed.

14. From this theoretical understanding, two important implications emerge. Firstly, didactic training is less effective because it lacks legitimate participation in field epidemiology. Courses front-loaded with terms and

definitions but without participation in practice leave trainees to guess what they need to know or be able to do.

15. Secondly, structured engagement in practice and mentoring supervision resolves the tension between global standards and local learning. Engagement in practice means interacting with local stakeholders, patients, data, systems. Trainees learn what to do and how to do it in the local context.

— Mentors model, support, and guide trainees in these contexts. They determine access to those contexts. Prior to that, the program chooses assignments based on local contexts to align with globally determined core activities. So, global standards, in setting broad categories of activities, become local as they are interpreted first by programs, then mentors, then the contexts into which trainees engage.

16. In summary, our study reveals that practical engagement and mentoring are crucial to the learning process in FETP, far more so than traditional didactic methods.

— To reinforce learning, intentional training courses should bring peripheral practice into the classroom through scenarios, simulations, stories, and case studies, rather than front-loading with definitions and terms. Global core activities should avoid being too prescriptive so that learning from national and local contexts can flourish.

— I look forward to hearing how these findings and interpretations resonate with your experience and hope that your questions can advance our interpretations.