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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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