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The Experimental Zone of Learning: Mapping the Dynamics of Everyday Experiment

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ABSTRACT
Arguments in science and technology studies have prompted us to rethink the meaning of experimentation in the wider context of our everyday life, though its dynamics have not been fully analyzed. This article argues that the legacy of the sociocultural approach to learning, with special reference to the Becker-Lave/Wenger dialogue, provides such a clue, and hence proposes a framework—"experimental zone of learning"—for such purpose. This zone is the outcome of the dynamic interface between constraints and sociotechnical devices, and this framework enables analysis of the diversity of such conditions, as well as their longitudinal changes through time.

A major leitmotiv in studies on human cognition and learning as mediated by sociocultural conditions has been criticism of standardized psychological experiments used as measures of psychological processes as they occur generally across life settings (Cole, Gay, Glick, & Sharp, 1971; Lave, 1988). Critical reflection on the ecological validity of research on the issue has coevolved with researchers' efforts to go beyond artificially created settings to include analysis of the constraints that are present in a wide variety of out-of-school (in the case of youth) and adult-dominated settings ranging from the study of schooling, literacy and apprenticeship in West Africa (Lave & Wenger, 1991; Scribner & Cole, 1981), street mathematics in a global context (Nunes, Schliemann, & Carraher, 1993), and diverse modern workplaces and other settings (Chaiklin & Lave, 1993; Engestrom & Middleton, 1996), to name only a few. Not only have these efforts clarified the diverse way that our sociocultural condition mediates the very construction of our cognition and learning, but they have also highlighted the specific situation of such experimental practices in laboratory settings (Cole, 1996; Lave, 1988).

It is the thesis of this article that these efforts can be substantially enriched by considering the rapid growth of empirical research on technoscience itself in the science and technology studies (STS) of recent years. Detailed examinations of the actual process of experimenting at the laboratory level (Latour & Woolgar, 1979; Lynch, 1985)—called "laboratory studies"—have contributed to transforming the image of the experiment from simply finding proof for a theoretical prediction in a rigorously controlled manner to something that plays a diverse and creative role in producing scientific facts. Previous reexaminations of past cases have also demonstrated its multiple roles in contexts like public demonstration as well (Gooding, Pinch, & Shaffer, 1989). In addition, both Hacking (1983) and Galison (1997) went even further to highlight the leading role of experimenting in producing new scientific knowledge often *ahead of* theoretical prediction.

In addition, Latour's (1983) claim concerning the way laboratories exert power to change the society as a whole has prompted researchers to view the laboratory in a wider social context, leading to claims that blur the boundary of experiments in and out of the ivory tower laboratory. Gieryn (2006), for instance, reexamined the Chicago School's sociological perspective of the city as the

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continuum of specific field sites and a sort of social laboratory. Krohn and Weyer (1994) claimed that what they call the "real life experiment" is now required because some high-tech experiments go beyond the capacity of the individual laboratory in academia. The growing importance of being experimental beyond laboratory settings under strict control—where the experimentation is extended into various sectors of our society—has been reported, ranging from the introduction of new technology into society (Levidow & Carr, 2007) to large-scale policymaking (Sabel & Zeitlin, 2010). In summarizing these trends, Gross (2015) claimed that such social experiments in real-life situations have actually preceded those in the laboratory setting, not vice versa.

Challenges to dichotomizing laboratory and lifeworld are not the monopoly of recent STS but have occurred within sociocultural traditions as well: An example is the effort to seek for a proper methodology that synthesizes the narrow but rigorous protocol of laboratory experiments with the diverse and largely qualitative character of observing situated practices (Cole, 1996). In addition, the recent flourishing of so-called design-based research (Anderson & Shattuck, 2012; Cobb, Confrey, diSessa, Lehrer, & Schauble, 2003) with its experimental intervention in classroom education—also called design experiments (Brown, 1992)—may be regarded as another example of this effort toward reconciliation. This approach, however, has been criticized for its insufficient exploration of the range of social ecologies embodied in most such research (Cole & Packer, 2016).

Although I recognize the productivity of such diverse attempts, these appear to me to remain within the somewhat conventional understanding, so to speak, where all the plasticity of laboratory experimentation does not seem to be fully incorporated into their arguments. STS's challenge not only has clarified such plasticity of laboratory experiments that deconstructs such a dichotomous view but also has the potential to open up a new research agenda dealing with, say, the dynamics of "experimentation in society," which previous approaches have scarcely addressed.

That said, the status quo of research in STS remains a collection of miscellaneous case studies confined to such limited topics as large-scale ecological trials or policy innovation, just mentioned. Although some attempts have been made to diagnose contemporary society in general as a "trial society" (Krohn & Weyer, 1994), and some recent laboratory studies have touched upon the sociological conditions that enable laboratory practice in the ivory tower (Frickel & Moore, 2006; Kleinman, 2003), still largely missing is an effort to explore a more fine-tuned framework for analyzing the various conditions that both enable and constrain such creative experimentation in everyday situations.

I claim that the clue for developing such a new framework lies in a certain aspect of the classical sociocultural and microsociological study of cognition and learning. These studies have looked at the experimental side, so to speak, of our everyday actions in various social settings, under diverse research programs such as neo-Deweyan analysis of practitioners' reflective capacity (Schön, 1983), ethnomethodological /ethnographical research on microinteraction with copy machines (Orr, 1996; Suchman, 1987), symbolic interactionism in jazz improvisation (Becker, 2000; Sawyer, 2000), and so forth. Among these diverse trends, I wish to focus specifically on the dialogue between Becker (1972) and Lave and Wenger (1991) concerning legitimate peripheral participation (LPP) and the possibility —or not—of learning in the actual workplace, as it is a prime candidate in terms of requiring a new framework.

There are two reasons why I have chosen this dialogue from among other candidates. First, it rather directly problematizes the very social conditions for such learning—not far from experimentation as characterized in this article—in a variety of real-world settings, in terms of both constraints and affordances. This topic remains largely missing in both STS and other microstudies of learning in situ, which are pivotally important to my objective. Second, even compared with subsequent theoretical development, such as that by Wenger (1998) on a "communities of practice" perspective (cf. Wenger, McDermott, & Snyder, 2002), the particular condition that enables local experiment—a specific zone for protecting what I refer to as experimental trials—is

more sharply demarcated there, especially in the formulation of the "periphery" in LPP, which is touched upon later.[1]

Becker's (1972) article focuses on the reality of learning either at school or in the workplace. Even while assaulting the uselessness of school learning as relevant only for surviving at school, Becker also claimed that real learning does not occur in the workplace because of various obstacles, such as the limited chances of proper guidance and the fatal cost of mistakes, which naturally limits novices' freedom to experiment (Becker, 1972, p. 98). Becker's radical conclusion is that learning is impossible either in or out of school, though he admitted that this is an extreme "ideal type" argument (Becker, 1972, p. 102). I tentatively call this argument "Becker's conundrum."

Lave and Wenger's (1991) ensuing LPP framework can be interpreted partially as their response to Becker's conundrum. They argued that despite obstacles that may incapacitate situated learning in the workplace, specific social spaces are often so structured that the newcomer can safely carry out trials without the risk of taking responsibility for possible failures. This is the pivotal significance of their term "periphery" in the LPP framework.

Summarized thus, this theoretical correspondence can be reconstrued as providing pivotal clues for formulating the condition and dynamics of experimentation as embedded in a social context: Becker's conundrum provided a list of possible obstacles to such local experimentation, as it presents the problem of the high cost of failures, as well as various constraints that curb such trials. Lave and Wenger (1991), in turn, proposed that certain local mechanisms can protect these trials from such obstacles, and they presented a variety of examples, such as African tailors along with modern workplace settings.

In the following pages, I develop insights taken from this controversy to formulate a framework for describing conditions for experiments embedded in a social context—which I call the "everyday experiment"—by focusing on three major points. First, I look at the importance of "failure" in the everyday experiment and discuss how to deal with its negative consequences. Both sides of the Becker-Lave/Wenger dialogue share the view that failure in situated trials can give rise both to learnability and to damage from various costs. Hence, the very feasibility of such trials hinges upon how to deal with this dual aspect of failure. To refer to and highlight this negative aspect of failed trials, I adopt here the term "toxin."

Second, on the negative side, Becker's conundrum address the variety of macrosociological constraints that directly influence local trials and may even overcome them. I use the term "constraint" to designate these macrosociological conditions. Third, I address local efforts to protect such trials by designing them in such a way as to decrease any resulting damage. I call these protections for experiments, which relate to one of the pivotal claims of the LPP framework, "sociotechnical devices." Finally, I call the very social space that enables such experimentation the "experimental zone of learning" (EZL).

The reason I introduce the preceding set of neologisms, rather than simply adopting the same terms—like "periphery"—lies in the very differences between their theoretical orientation and mine, despite the apparently shared interest between us. First, the center of my EZL framework is not a person or a community like in LPP, but experimentation itself. Luhmann's (1995) social system theory—in a discussion of the way society is self-producing within the recursive network of communication—posits that "communication" is the *sole* component of society and not a person or human agency. Likewise, this article is an attempt to demarcate the conditions that either allow or constrain a continuous flow of experimentation in the real-world setting. This treatment allows for a more finely tuned approach to preceding concerns vis-à-vis STS.

Second, because of this different focus, the controversy in some parts of situated learning theory concerning matters of the individual versus the collective (Barton & Tusting, 2005; Hughes, Jewson, & Unwin, 2007) is not important to the EZL framework. Flows of experimentation may take place at either the individual or the collective level, so our attention to everyday experiment does not entail a return to individual psychology.

However, I also differentiate my stance from the preceding understanding of social experiment in STS, which tends to highlight the recursive process of knowledge production between the social

experiment and the academic laboratory (Gross, 2015). In the EZL framework, this recursive process is not confined to this narrow laboratory–society continuum; rather, it should be extended to a more general reflective flow of experimental trials that may circulate in diverse social settings, whereas the outcomes similarly produce both knowledge and tacit skills, if not as exact as those from a laboratory.

This recursive flow of trials in localized situations constitutes the tentative definition of "everyday experiment" in this article, which should also be distinct from mere coordination of our action in every situation, like our body's microslips (Sayeki & Sasaki, 1990). Learning, in turn, is tentatively defined as the continuous flow of such everyday experiments along with their outcomes; the conditions that both enable and curb it become the EZL. Although it is true that this way of defining learning does not cover all the connotations of learning for various approaches to the subject, involving that of sociocultural approach, this specific definition is expected to result in a unique mapping of the dynamics of EZL as widely distributed throughout society and constantly fluctuating through time, and this mapping ability thus may represent what the other approaches cannot afford to do.

In the following pages, I first detail the three major components of EZL, namely, the concept of toxins, (macrosociological) constraints, and sociotechnical devices. A case study in an emergency medical center follows, which presents observations concerning the local effort to sustain EZL and its longitudinal change. The Discussion section locates this case in the wider context of different types of local situations where these components may have different configurations, and argues further for the potential of this framework.

Toward the experimental zone of learning

Toxins

The first among the major components that constitute the EZL framework is toxins, a term I use for the negative consequences created by any kind of experimental trials in situ. Preceding arguments on social experimentation in STS have referred to either the creative significance of failure for knowledge production (Gross, 2015) or the possible damage it may inflict (Krohn & Weyer, 1994). I have noted that in the Becker-Lave/Wenger dialogue, the issue of toxins plays a pivotal role, though the researchers have different views on possible ways to deal with them.

To observe the way toxins function in circumstances differing from those in these precedents, it is worthwhile to look at a number of studies, conducted in technologically hazardous organizations, which have contributed to furthering our understanding of the way toxins work. Nakaoka's (1974) pioneering research on a chemical plant complex—from which the term "toxin" originates—detailed the paradox of labor issues stemming from frequent explosions in the 1970s in Japan. He found the bulk of maintenance work, usually confined to checking signals throughout the plant, extremely monotonous. Only when the machines gave trouble was there an opportunity to experiment with the machines to gain a better understanding of the system. In fact, many of the troubles—minor toxins, in my terms—in the early phases of chemical plant construction afforded chances to learn about the machines, that is, provided an extensive EZL, whereas the outcome, namely, the gradual improvement of the system, ironically decreased the chance to fix failures as the system became flawless, thus shrinking the EZL. As a result, if a large accident happened, only retired staff could deal it, because the younger generation had experienced only the monotonous labor just described with few chances to experiment. This case provides a good example of the paradoxical shrinkage of EZL, owing to the very efforts to eliminate flaws from the system.

High reliability organization (HRO) studies, which have examined diverse safety practices in such organizations as aircraft carriers, control towers at airports, and nuclear power reactors, also provide rich examples of toxins/EZL relations, as well as concrete ways to avoid such shrinkage (LaPorte & Consolini, 1991; Roberts, 1993). For instance, in certain places, a report on every minor mistake is both obligatory and highly praised for enabling further examination to avoid lethal accidents

(LaPorte & Consolini, 1991; Reason, 1997). This system can be interpreted as a particular effort to find a way to avoid the longitudinal shrinkage of EZL by a specific organizational contrivance, which I soon discuss as sociotechnical devices.

Constraints

Vis-à-vis such toxins, the second component that matters in the dynamics of EZL is (macrosociological) constraints. Compared to laboratory settings in academia where experimental trials may be generously tolerated, the experiments in real-world situations may face various macrosociological factors that slow or entirely eliminate such trials. Becker (1972) and Marshall (1972) have both been eloquent in discussing a variety of factors that exert a negative influence on trials in concrete situations, and the following sections extend their notion of constraints to those that they have not fully discussed.

Spatio-temporal constraints

Both Becker (1972) and Marshall (1972) emphasized that trials in real-world situations should occur in the proper space, both to experiment and to observe others doing the work. In fact, the periphery in LPP can be interpreted as both abstract social space and the actual physical layout (Lave & Wenger, 1991). EZL inherits this attention not only to space but also to time, which is crucial for understanding such constraints. For both ordinary workplaces and the laboratory, the term "doability," which refers to the important ability of experimenters to finish an experiment within the expected amount of time, is recognized as pivotal (Fujimura, 1996). In the case of emergency medicine presented here, this element of temporality plays a distinctive role in keeping EZL alive vis-à-vis even other types of medical settings.

Economic constraints

Economic elements range from the cost of toxins to the macroeconomic structure surrounding EZL. Although Latour and Woolgar's (1979) nonchalance concerning the economy of the laboratory life was criticized in terms of their not properly noting that Guillemin's laboratory was endowed with $150 million (Bimber & Guston, 1995) for collecting a large number of cow brains for their research (Wade, 1981), both Becker (1972) and Marshall (1972) are attentive to the work of such economic constraints on learning in situ; the latter, detailing the learning of butchers on the spot, goes even further in discussing not only the different economic costs of different types of meats, which affects butchers' work, but also the differences in the acceptability of badly cut meats for people at differing economic levels. Economic constraints differ visibly from shops to HROs to the case studies presented next, leading to different ways of constraining EZLs in each case.

Ethico-legal constraints

Although the issue of ethics and law has been avidly discussed in STS in relation to emerging technoscience, this constraint appears to have been less focused in the previous studies of learning in context. Ruined clothes, failed hair, and wrong prescriptions have not only different economic consequences but also varying significance in terms of ethics and law. The aforementioned troubles in chemical plants appear to have been within the confines of legal acceptability (Nakaoka, 1974), whereas in current medical practice, a mistake might lead to serious issues of legal responsibility that could shrink the EZL dramatically. Nunes and Barros's (2014) comment on Becker's own ethnographic study of medical education (Geer, Hughes, Strauss, & Becker, 1961) can be reinterpreted as discussing the diminishing EZL caused by the changing traits of ethico-legal constraint: from a relatively autonomous period—during which EZL could be somewhat protected—to that in which mounting lawsuits against medical malpractice are threating medical practices, which are construable as a direct menace to EZL. This type of constraint is also palpable in the following case of emergency medicine.

The Issue of power

In contrast with the constraints just identified, the issue of politics and power needs to be treated differently, as this is deeply entangled with the multifaceted nature of the concept of power itself. Lukes (1974) pigeonholed the variations in defining power, beginning with Weberian coercion, through the Parsonian ability to act in concert, and culminating in Foucauldian institutional canalization. Seen from this perspective, "political constraints" (in terms of power) may sound redundant, as the term "constraint" in itself already implies multiple aspects of power. Hence, in the following case study, I provide concrete examples demonstrating that power matters in terms of, say, intra- and interorganizational power politics, rather than using the term "political constraint."[2]

Sociotechnical devices

Vis-à-vis the constraints that curb the development of experimentation in situ, the local apparatuses that protect and afford such trials in situ—the EZL—are "sociotechnical devices." The adoption of this specific term draws part of its theoretical inspiration from that of "infrastructure studies," now widely discussed in the STS community (Star & Bowker, 2002; Star & Ruhleder, 1996), as well as in the relative recent research on learning in relation to extended tool-mediated activities (Bruni, Gherardi, & Parolin, 2007; Guribye, 2015). Sociotechnical devices and infrastructure here have in common the feature of being an assemblage of both human and nonhuman elements that afford the various activities hinging upon them; however, the former is more site specific and not always as invisible as the latter. In addition, that these devices can be organizational also differentiates them from the connotation of a simple tool as well.

Sociotechnical devices can be sets of technical tools and apparatuses, organizational contrivances, and even economic routines. A laboratory in this sense is a large collection of such devices, and a system of African tailors that allows for the recycling of failed cloths (Lave & Wenger, 1991) is another example of such devices. HRO studies also provide ample examples of such devices, like the routine of encouraging a report of the slightest malfunction or errors, as noted earlier (LaPorte & Consolini, 1991).

The emergency medical center case

Following the outline of the three major components of EZL, in this section I present a brief case study of an emergency medical center in Japan where I conducted field research in 1993 for 1 year. Medicine is important for examining the dynamics of EZL owing to its changing constraints in recent years as seen in various factors, such as patient safety, financial crises and ensuing marketization, and so forth.

Japan has a relatively well-established network of emergency medical centers, which were started in the 1960s to deal with increasing traffic accidents in an era of rapid economic growth (Kidokoro, 2001). Japanese emergency medicine is distinct from the American-style emergency room (ER; Roth & Douglas, 1983; Zink, 2006) in having a three-level structure based on the critical level of a patient's condition.

My research was conducted at a center specializing in the critically ill at a university hospital. The center is fully equipped with an operation room, intensive care units (ICUs), and a great deal of other equipment. Emergency medicine demands a huge amount of diverse knowledge and expertise to cover symptoms ranging from multiple concussions to acute poisoning. The center's focus on the emergency phase may decrease its burden, but collaborative skill is required with doctors from different disciplines.

In Japanese emergency medicine, patients are often treated for longer than in the average ER in the United States, as evidenced by the term "acute" rather than emergency as their official denomination. For instance, some centers favor brain hypothermal therapy, a complex method that requires a longer term of treatment than is normal for an ER. These aspects, in fact, contribute to expanding EZL in emergency medicine in the Japanese style (detailed later in the article).

Emergency medicine has also changed over the years: Treating multiple concussions caused by traffic accidents was a focus in the 1960s, whereas in recent years the focus has moved toward internal symptoms, such as heart attacks. Such a longitudinal change also has various effects on the waxing and waning of the EZL, as demonstrated at various levels in their daily activities.

Various constraints in and out of the emergency center

Against such a background, various constraints influence the actual dynamics of the EZL in the center. Superficially, the temporal constraint characterizes it most visibly, as the majority of the patients are brought in with grave conditions that demand speedy treatment. This temporal constraint works negatively for the sustenance of EZL in the various contexts of the center. Spatial constraints as well are also evident in the fact that patients must be brought to the center in a matter of minutes. Thus, the geographical placement of the center is important; in addition, the physical layout of the ward is so structured that patients' changing conditions can be monitored from any spot, which may contribute somewhat to the EZL, as constant observation is enabled wherever it is.

Such constraints in time and space are generally restrictive for the EZL as a whole; however, they are somewhat mitigated by the relative characteristic looseness of this medical genre. The fact that the Japanese keep patients longer than the global standard works positively for the EZL, as shown later. In addition, economic constraints did not seem to have much of an effect on the EZL in this center. Although Japanese emergency medicine has been known to be a money loser (Okamoto, Matsushima, Hara, & Terai., 2006), the head of the center at that time—who was concurrently vice-director of the hospital—appeared to be permissive on this issue, as he thought that such a center was highly symbolic for showing the public that the hospital was well equipped, which otherwise might seriously shrink the EZL.

The ethico-legal constraint is, in fact, a hazy zone for this genre of medicine. The center's patients are very often in a condition of cardio-pulmonary arrest, too late for resuscitation. An ambiguous margin exists here between natural death and emergency doctors' failure to resuscitate, allowing for these doctors' rather rough and rushed ways of treatment. Thus, even though medical accidents remain a serious issue in the center, which may have a negative effect on the EZL, this hazy domain also allows the EZL to remain alive, as detailed later.

Sociotechnical devices

In addition to these constraints, which are more or less related to the specific nature of emergency medicine, the sociotechnical devices that afford the EZL are rather distinctively characterized in the center by concern for the patients' safety. From among the variety of such devices, I discuss three. The first is locally called the "prescription table," a small, formalized sheet listing all the pertinent orders of the doctor in charge of a given patient. The list contains such items as various types of injection and special prescriptions and is followed by checklists for four meetings before and after the order's execution. This piece of paper literally circulates through the center, just as leukocytes circulate through the human body to hunt for viruses. Each local change in the orders may be checked at any time, either on the spot or in meetings, to keep track of what is going on.

The second device is the meeting (*kanfa*) itself, which is held twice a day during the day shift with all of the doctors present. In these meetings, streams of knowledge and experience are both checked and discussed. A brain neurologist who had once stayed at the center recalled the endless diversity of the range of discussion, compared to the somewhat limited ones in his own department. This diversity, however, may pose problems for novices. In one example, a novice otolaryngologist could not provide a reason for the specific amount of a diuretic drug that had been prescribed for a particular patient. Her uncertainty naturally invited sneers and criticism from her seniors, but the seniors did not then follow up with direct instruction. Rather, they let her do the job, as part of the

necessary recursive flow of experimenting, by correcting any possible toxins arising from misjudgment; this approach is essential for EZL.

These meetings occasionally look much like those in a laboratory, reflecting the center's character as part of a university hospital. For example, one patient was suffering from internal intestinal bleeding that would not stop. The *kanfas* on the case went nowhere as the senior doctors offered a variety of indecisive hypotheses. Despite the pessimistic prognosis, the patient survived and even improved slightly. A few days later, a young specialist in gastrointestinal medicine who had been invited to the *kanfa* observed that the problem might have been caused by a blood transfusion gone wrong. In this case, the *kanfa* proved itself as a sociotechnical device that was able to provide enough resources for thorough examination of any issues, thereby producing new knowledge. This incident illustrates another aspect of this device that sustains the EZL.

The third device is a specific *rule* for this center: The doctors are required to write down all of their orders in a "cadex," a thick file controlled by the so-called "lead nurse" of the day, who is in charge of all the nurses' activity in the center. Doctors are not allowed to give direct orders to the nurses but to go to where the lead nurse checks each order; then the order is passed from her to the bedside nurses. Such critical scrutiny of the doctors from the lead nurse—a temporary reverse in the relationship between doctors and nurses (Hughes, 2008; Stein, 1967)—serves as a powerful filter for all possible toxins (in this case, mistaken orders), especially from ignorant novice doctors. Because it ensures patient safety, it is a powerful guarantee that the EZL will survive.

EZL in action

Given this background, various types of the EZL can be witnessed in other aspects of the center's activity. For example, each patient's unique physiology means that standardized dosages represent a starting point, whereas the proper amount should be carefully explored through the recursive flow of trial, observation, and retrial that is afforded by an EZL.

A case from a psychiatric ward for chronic patients that I observed in the early 1990s may be helpful by way of comparison for understanding the relation between such the EZL and the toxins hidden in medication issues. One day the doctors in the ward decided to increase the dosage of powerful tranquilizers to dispel a delusion in a patient suffering from persistent persecution mania. Alarmed by the subsequent heavy drowsiness of the patient, the doctors then gradually decreased the medication. The unexpected result was that the delusional fear rebounded, and the patient, afraid that the doctors would attack him, injured one of them with a knife he had brought in secretly for self-defense.

This kind of dramatic example represents both the existence of an extensive EZL and the failure to avoid the toxins that occurred in the form of the patient's relapse into persecution mania. This case has no equivalent in the emergency center, where it is largely the temporal constraints specific to emergency medicine that afford the more limited EZL there. For instance, brain hypothermia therapy—one of the treatments highlighted at this center—consists of cooling the temperature of patients suffering from brain concussion to avoid brain swelling, which may cause brain death. Such cooling of the body, however, may cause the immune system to malfunction, leading to further infection. Hence, this therapy requires a rather rigid set of protocols and rapid intervention for 24 hr; thus, it is very difficult to achieve enough EZL-like elbow room for experiments, even by the veteran staff there.

A certain level of EZL can be observed in a later phase, however, when a patient stabilizes after coming out of ICU. At that time, doctors and nurses may use more trials in medication or other treatments. Rotating novice doctors may decide what to do at the bedside, though a certain level of uncertainty always characterizes their decisions, owing to their lack of experience; thus, the process naturally zigzags with constant changes in orders, even if it is carefully monitored by supervisors with the help of the various sociotechnical devices just detailed.

The nurses are also occasionally involved in such trials. In fact, patients cared for outside of the ICU provide the best opportunity for observing how EZL works for the nurses, too. One patient was

very shaky when getting out of bed, owing to poor physical balance; thus, the nurses feared that he might fall out of bed. They considered various safety measures, such as a medical straitjacket or some kind of sensing device. Having tried a couple of feasible ideas, they eventually concluded that more frequent monitoring of his condition was sufficient to ensure his safety.

Another crucial element of the EZL can be observed in borderline cases involving incoming cardio-pulmonary arrest patients. Such patients are supposed to be resuscitated for half an hour according to regulations. Once the time has passed and the patient's death is confirmed, doctors tend to continue to examine the patient's body, using such tools as ultrasonic echo or groping for the central veins usually used for dripping. One might question the necessity of such a postmortem examination, but in fact this imprecise border between the urgent necessity of treating a living body and examining a dead one is the sizeable realm of EZL that is specific to this kind of center and is rarely found in other types of medical settings. Its legitimacy, however, could be contested by a surge of further ethico-legal constraints in the future.

EZL and experimentation at the collective level

One of the intriguing aspects of the EZL in the center is that it is not confined to either novices or individuals; rather, it can be observed even at advanced levels and collectively. One such case was observable when an incongruence occurred between the amount of a drug given and its record. The nurses in charge launched a full-scale investigation to track down the discrepancy; they reexamined every step by interviewing all the nurses who had taken part. After a day of examination, they concluded that the error had resulted from an ambiguous way of counting a set of ampules. The center's policy of allowing this kind of mobilization of nurses' time and manpower is a typical example of a sociotechnical device used for the collective understanding of the organizational problems hidden in such failures, and it is supported by the organizational level of EZL.

However, the ability to sustain the EZL at this level appeared to be somewhat shaky and dependent on circumstances. In one case, an erroneous order from a doctor passed unnoticed, eventually being reported to the safety committee in the hospital as a minor error. The doctors' reaction was lukewarm, however; they did not seem to care that this kind of inattention might lead to possible shrinkage of the EZL at the collective level. The nurses occasionally showed similar weakness: in another case, a novice nurse failed to give the proper dosage of a drip to patient. The senior nurse noticed it and immediately stopped the drip. The nurse was severely scolded for her lack of vigilance, but no one fully explored the reason for the mistake. Here also the effort to expand the EZL by examining the toxin was replaced with a prevalent folk-theory that attributes mistakes solely to the "absentmindedness" of the practitioner, with no attempt made to discover more complex reasons that might have involved both human and nonhuman factors.

Finally, the other intriguing feature of the EZL is related to constant ongoing experimentation relating to the form of the organization, which were a response to rapid environmental change. My research was conducted at the end of the older rotation system wherein some trainees could choose to practice emergency medicine for 3 months. In this older system, there was a kind of fluctuating organizational structure from the senior doctors down to the patients: On 1 day, for example, Senior Doctors A, B, D with Novices a, b, e, f might be on duty. The next day, Doctors C and E would be on duty with Novices b, c, d, f. In this system, the responsibility was collective, with the entire group of senior doctors taking charge of all the rotating novices, each of which was assigned the care of two patients. This system was intended for information sharing among doctors while sustaining EZL for novices' trials; however, the seniors began to worry about the possibility of toxins in the form of miscommunication among the doctors owing to such irregular rotation, and of collective irresponsibility, that is, uncertainty about who would finally take charge of whom.

A temporary drought of incoming patients during the summer also prompted them to try a new system: Doctors and patients were divided into two teams to secure tighter control over patient care. At the very end of my stay, the new national training system prompted a further change in which

every trainee was required to take 2 months' training in emergency medicine. This move resulted in a sudden increase of rotating novice doctors: from six to more than 20 at the center. Senior doctors were alerted further to try a new system by assigning a senior doctor to two patients, with novices assisting the senior in charge. This change was accompanied with a sudden rise in the number of official lectures, which had hardly been done before. Although I was unable to follow the consequences, it was easy to see that this new system did not at all guarantee a local level of EZL at the center.

At least two elements deserve attention in this case. The first is that constant change in the organizational structure is in itself a sort of experimentation that is afforded by its own EZL. The very administrative structure serves as a sociotechnical device to afford this experimentation, namely, the relative autonomy of the center in terms of decision making, which enabled such trials without interference from the hospital bureaucracy.

Second, this level of EZL and the organizational experiments are meant to sustain the EZL at a low level, that is, to avoid shrinkage at the lower levels of the EZL which could be caused by organizational maladaptation to the rapidly changing environment. This means that it is possible for an EZL to have a nested structure, namely, an EZL within an EZL, which as a whole constitutes the complex dynamics of experimentation at the various levels of the center's activities.

Discussion

It was the recollection of a senior doctor at the center that led me to the seminal concept of the EZL. This doctor related that his supervisor had once told him to try whatever he believed to be right for the patients and that he, the supervisor, would take full responsibility for the consequences. The doctor asserted that this approach is at the heart of the center's modus operandi.

There are a few advantages to analyzing EZL in this specific case study. First, it is a good exercise in understanding how toxins work in concrete contexts that differ from each other. Compare this case with certain classical instances in the study of learning in context, such as being a butcher's apprenticeship (Marshall, 1972) or the example of the African tailors (Lave & Wenger, 1991). In medical practice, constraints related to safety are at the forefront as toxins must be neutralized through the webs of specific sociotechnical devices, whereas in the former cases, the pivotal constraints in relation to bad meat or failed cloths are economic, signifying different types of toxins that would require different sociotechnical devices to protect the EZL. In summary, the dynamics of the EZL as a whole in the emergency center share a few traits with the HRO case studies just cited.

However, because the case studied here is part of the university hospital, it has a couple of characteristics specific to its own EZL dynamics. Although a few of the sociotechnical devices are directly concerned with toxins that are hazardous to patients' safety, some elements—such as the kanfa's examination itself—visibly have a laboratory-like character. In addition, the fact that emergency medicine deals with patients in cardio-pulmonary arrest provides an undefined zone of EZL for experimentation, despite the fact that temporal constraints often work against the EZL, as in a flight control tower or operations on an aircraft carrier where temporal elbowroom is minimal (LaPorte & Consolini, 1991).

In addition to this comparative perspective, this case also provides dynamics for examining the longitudinal changes of an EZL vis-à-vis macrosociological changes in its environment. Not only are growing concerns about patient safety and the rising costs of medication significant here in terms of changing constraints, but also the overall situation of emergency medicine has been rapidly changing in recent years, which has also greatly affected the dynamics of the EZL with regard to temporal concerns. Such longitudinal fluctuation of the EZL has already been clearly hinted at in preceding studies, such as Nakaoka's (1974) study on chemical plants, mentioned earlier, where the successful establishment of a particular system eventually led to radical shrinkage in the EZL; in my case, however, the dynamics of the EZL appear to be more complex, not confined to the systems' dynamics but related as well to the longitudinal dynamics of multiple constraints upon the local EZL.

Finally, this case also contributes to understanding the multilayered aspects of the EZL, namely, its nested structure. As pointed out previously, the EZL in principle is not confined to an individual level of experimentation but can be extended to the collective level, as shown earlier in the case of organizational experimentation. Thus, we are prompted to understand the EZL as multilayered, which eventually may lead to a further nonlinear trajectory of the EZL as an outcome of mutual interference in the different levels of EZLs. This, however, is an open question to be answered in future research.

Conclusion

The rich inventory of research on cognition and learning in diverse sociocultural conditions has played an important role by expanding understanding of a topic once narrowly confined to experiments in a laboratory by way of emphasizing a scientific approach. The framework itself can benefit by meeting the challenge of STS that has been changing our conventional view of both laboratory and at-large experimentation, with its seminal emphasis on experiment as deeply embedded in society from the beginning. This article has attempted to develop a synthesis of this emerging view in STS with part of the legacy from the sociocultural and microsociological approach to learning in context, namely, the dialogue between Becker (1972) and Lave and Wenger (1991) on the (im)possibility of situated learning in various types of workplaces. I have shown that this dialogue provides a pivotal clue for developing a more finely tuned framework to analyze the local conditions that afford what I call *everyday experiment*. The three major conceptual components developed here are (a) toxins, the negative consequences of experimental trials and the various ways of dealing with them; (b) constraints that demarcate possible zones where such experiments may be allowed; and (3) sociotechnical devices, a set of assisting efforts, both human and nonhuman, that afford such experiments. In addition, the very specific zone that enables such experiments in situ is called the EZL.

This formulation entails a number of points: First, the nature of this zone differs radically in various sociocultural settings, so this framework encourages further comparative studies between different sociocultural conditions (cf. Cole, 1996); second, this framework need further longitudinal and historical studies as well, given that the EZL is essentially an unstable social space produced by the ever-changing interaction of the factors noted earlier. This view is instrumental for avoiding its possible reification in an ahistorical manner. Third, as this framework is not confined to novices or to the individual level but is applicable to the collective level, the EZL can have a nested structure—an EZL within an EZL—which is a subject for further exploration, as this has been hardly examined either in STS or in the sociocultural studies of learning.

Probably, however, one of the largest advantages of this approach is that this framework may enable a radical reconsideration of the existing way of bridging the gap between laboratory and everyday life, especially in the manner of preceding STS arguments on social experiments, where the main focus has often been the cases of highly educated citizens and relate to advanced technology. This article has attempted to replace this kind of bias by drawing on lessons from the rich legacy of the sociocultural approach to learning—involving, say, unflashy butchers and African tailors—to promote a more symmetrical approach to the issue. In this sense, I am convinced that experimentation is not monopolized by laboratories in the ivory tower. Rather, it is deeply embedded in our everyday lives, constantly producing the tiny improvisations and reflections that will eventually change our world.

Notes

1. In Wenger's ensuing formulation, this periphery becomes somewhat diluted with further classification without a clear focus on what the periphery might mean in the context of my theoretical concern here; see Barton and Tusking (2005) and DePalma (2009) for the limited and yet unexplored possibility of Wenger's framework.
2 This issue of power in terms of canalizing the flow of experiment in the direction of a specific purpose is deeply related to issues of both instruction and innovation, which cannot be treated here owing to space limitations.

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