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# **THE NEGLECTED PIECE OF HEALTH IT ASSIMILATION: UNVEILING THE LEARNING TRAJECTORIES OF ROTATING PHYSICIANS**

## **Abstract**

Job rotation is a necessary and an important part of physician medical training. As the use of HIT becomes a central part of physician work, it is imperative to understand how job rotation can affect the assimilation of HIT for physicians and healthcare organizations. Using situational learning lens to analyze the job rotation experiences of Junior Physicians in a hospital, this study identifies the different forms of situated learning that occurs during system assimilation at the individual and organizational level and the different assimilation outcomes are associated with different forms of situated learning. We conducted an interpretive case study among rotating physicians in a public hospital and identified five types of individual/organizational level learning trajectories. This paper contributes to the existing knowledge of IS assimilation by exploring the relationship between cross-organizational job rotation and the success of HIT assimilation in hospitals.

Key words: Health IT assimilation, job rotation strategy, situational learning theory, learning trajectory, case study

# **THE NEGLECTED PIECE OF HEALTH IT ASSIMILATION: UNVEILING THE LEARNING TRAJECTORIES OF ROTATING PHYSICIANS**

## **1. INTRODUCTION**

Research on information systems (IS) assimilation is abundant. This stream of research generally assumes that users' knowledge of the focal IS increases with the duration of its assimilation in the organization. That is, studies examining the early stages of IS assimilation typically adopt the perspective that system users have limited knowledge of the system and are expected to encounter great challenges when using it (Bala and Venkatesh 2013, Deng and Chi 2012, Leonardi 2013, Morris and Venkatesh 2010, Sykes et al. 2014, Tong et al. 2015). Hence, organizational support such as training is deemed critical to helping new users get familiar with the system (Sykes 2015, Tong et al. 2015). Correspondingly, those focusing on later IS assimilation stages accept that system users have rich experience in using the IS and thus possess stable attitudes and knowledge toward the system (Kang et al. 2012, Li et al. 2013, Liang et al. 2015, Sun 2012).

While prior literature on IS assimilation has generated insightful findings, directly applying the findings may not be fully applicable in Health Information Technology (HIT) assimilation in hospitals where job rotation is practiced. Defined as periodical lateral transfer of employees between work assignments (Arya and Mittendorf 2004, Campion et al. 1994), job rotation is a widely used strategy for junior physicians' (JPs') career development. In the United States, resident physicians are often required to rotate between medical units or hospitals to acquire necessary skills of clinical practice. Similar requirement is also observed in other countries. For instance, as part of the medical training program, JPs in Singapore are mandated to rotate across departments or hospitals every few months in their first year (SingHealth 2014).

While job rotation can benefit JPs' medical knowledge (Gordon et al. 2006, King and Ranft 2001), this strategy might exert detrimental effects on hospitals' assimilation of HIT. Research shows that job rotation enhances one's general business skills (e.g., networking capability) more than technical expertise (e.g., using a HIT) (Campion et al. 1994). JPs who rotate periodically among hospitals are unlikely to be proficient in a particular HIT, even though the system could have been implemented within a hospital for a long time. Furthermore, frequent change in work environment and task assignments can cause JPs to experience increased workload, great uncertainties and lower organizational commitment (Arya and Mittendorf 2004, Dam 2005). To the extent that the success of an information system (IS) depends on its effective utilization by system users (DeLone and McLean 1992), it is imperative that the hospital management understands how rotating physicians overcomes the challenges of job rotation so that appropriate managerial interventions can be devised to effect successful assimilation of HIT.

Despite the increasing attention placed on HIT adoption and assimilation (e.g., Kane and Alavi 2008, Kohli and Kettinger 2004), to our best knowledge, the effects of job rotation on HIT assimilation outcomes have not been examined in extant literature. Prior literature mainly focuses on job rotations within the same organization, whose findings may not always hold in a cross-hospital rotation setting. In this study, we employ situated learning theory (Lave and Wenger 1991) as the theoretical lens to examine the effect of rotation on HIT assimilation. Situated learning theory depicts how learning is embodied at individual and community/organizational levels, which provides a suitable lens for us to explore how rotating physicians learn to use the HIT and the related assimilation outcomes. This paper departs from the prior literature by exploring the following research questions: *1) How does a rotating physician learn*

*to use and perceive the benefits of a HIS? 2) How can a hospital's cumulative knowledge of its HIS be affected by the job rotation strategy?*

To address these research questions, we conducted an interpretive case study among rotating physicians in a public hospital in a commonwealth country. The results of this study identify five types of individual/organizational level learning trajectories. This study adds to the existing knowledge of IS assimilation by exploring a prevalent yet less focused context for IS assimilation in hospitals. Through exploring the relationship between cross-organizational job rotation and the success of HIT assimilation in hospitals, hospital management can effectively manage rotating physicians' HIT utilization.

## **2. USERS' IS ASSIMILATION IN ORGANIZATIONS**

When an IS is rolled out in the organization, system users who are new to the system typically engage in a learning process to equip with the system-related skills. Conventional learning theories define learning as a cognitive process, which selectively transfers comparatively abstract and codified bodies of knowledge from one context to another context where the knowledge can be applied (Contu and Willmott 2003). This school of theories is based on the assumption that an objective reality exists and can be understood to guide the behavior (Lapointe and Rivard 2005). Hence, one's learning process is isolated from the work practice and is usually achieved through canonical means such as training and mentoring from experts (Brown and Duguid 1991).

Despite the insights provided by the extant literature and the conventional learning theories, the practice of job rotation poses challenges to the organizations to apply the existing body of knowledge directly. Specifically, for those employees just rotated into an organization, they do not have much expertise in using the focal IS, although the system could have been assimilated for a relatively long time. Moreover, organizational support structures such as large-

scale systematic training are typically prepared only when the system is initially rolled out. The conventional learning theories infer a knowledge-practice separation view of learning, which is also challenged by some researchers (Brown and Duguid 1991, Contu and Willmott 2003).

Inside an organization, an employee constantly interacts with the work environment and hence, his/her learning process should not only be limited to the canonical trainings but to also include the contexts he/she has experienced and is interacting with (Lapointe and Rivard 2005). Hence, it is less understood in the IS assimilation literature as to how the rotating employees can learn to use the IS.

In this study, we posit that “learning-in-working” as advocated by situated learning theory is a better perspective reflecting how an employee acquires knowledge within organizations (Brown and Duguid 1991). In line with the “learning-in-working” perspective, Lave and Wenger's situated learning theory (Lave and Wenger 1991) has been recognized as a pivotal and sustained representative (Contu and Willmott 2003). Situated learning theory posits that learning is situated within the communities-of-practice, where the knowledge can be constructed via multiple situations (Lave and Wenger 1991). Specifically, one’s process of knowledge construction is both *historically embedded* (i.e., learning from participation/ experiences in previous communities-of-practice) and *socially embedded* (i.e., learning from current work environment) (Contu and Willmott 2003). In addition, learning is also embodied as “an integral part of generative social practice in the lived-in world” (Lave and Wenger 1991, p.35). Hence, communities-of-practice can be reproduced via learning from new comers to the community (Lave and Wenger 1991).

The review of the situated learning lens suggests that situated learning can occur at individual level and community (organization) level. In the context of this study, job rotation can

introduce rich and diversified knowledge to a junior physician. Both experiences in using comparable systems in the previous as well as the current work environment can be useful sources of learning for a physician to use a HIT. Toward this end, context-sensitive understandings of the system are acquired, shared, and elaborated. Furthermore, the hospital's knowledge base of the system could also be updated/reproduced by the knowledge brought by the newly rotated physicians. Despite the relevance, the development of this theory in the context of job rotation is still at a nascent stage because it does not explicate the underlying learning processes that are triggered by varied sources of learning. Moreover, prior IS literature did not explicitly differentiate system users' varied learning processes with a relatively stable IS.

### **3. RESEARCH METHODOLOGY**

#### **3.1 Research Context**

We conducted our study at a public hospital (APH)<sup>1</sup>. APH has about 800 beds and offers an entire range of medical services from general surgery, internal medicine, cardiology, to orthopedic surgery and dermatology. Physicians are categorized based on four levels of seniority (in increasing order): house officer, medical officer, registrar and consultant. To equip them with the basic skills of clinical practice, JPs (i.e. house officers and medical officers) are required to undergo rotation postings for a few years as part of their medical training program. All JPs, including house officers and medical officers, have to rotate among different departments and different hospitals periodically so that they get exposure to different care settings (e.g. inpatient and outpatient) and specialties. Rotation postings are done either intra-hospital (between different medical units of a hospital) or inter-hospital (between different public hospitals in the country).

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<sup>1</sup> For the confidentiality issues, real names of the hospital and CPOE used will not be disclosed.

The focal HIT in this study is the Computerized Physician Order Entry System (CPOE). APH uses CPOE for lab and radiology orders in both the outpatient and inpatient settings. The goals of adopting CPOE include speeding up the ordering process, improving patients' safety and reducing the hassle of writing paper-based orders. The CPOE provides a wide range of functions to support the routine work processes of physicians such as ordering tests, viewing results, tracking orders through system flags and retrieving patients' historical information. Additionally, the CPOE also provides departmental *order sets*, which are predefined groupings of orders that comply with disease management principles. The order sets function allows physicians to search and select a set of pre-defined orders based on a patient's condition instead of entering orders individually. All JPs had to use the CPOE. They were given a short training (about two hours) that provided an overview of the CPOE before they started work.

### **3.2 Data Collection and Analysis**

Data collection began with on-site observations of six JPs to understand the hospital context and workflow around the CPOE better. During the observations, researchers noted down the general work process without capturing any patient data. Interview scripts were first designed based on prior literature and further contextualized using these observation data. Our sampling frame consists of JPs from medical units where the use of the CPOE was necessary and where JPs were required to rotate periodically. Hospital management provided a list of JPs from various units based on our selection criteria. The researchers then made phone calls and sent emails to them to request and fix an appointment for the interviews.

Interviews were subsequently conducted with the physician leading the CPOE project and twenty-nine JPs randomly selected from the twelve units where the use of the CPOE was

necessary and where JPs must be rotated to periodically<sup>2</sup>. They include: Accident and Emergency, Anesthesia and Surgical Intensive Care, Cardiology, Dermatology, Otolaryngology, Ophthalmology, General Medicine, General Surgery, Psychological Medicine, Rehabilitation Medicine, Sports Medicine, and Urology. The detailed information for these twenty-nine JPs is reported in Table 1. Interview participation was voluntary – the interviewees were required to sign the consent form before the interview could begin. The interviews were conducted in the hospital, at the physicians’ convenience. Interview questions were exploratory in nature, open-ended and slightly tailored to the interviewees’ role and work nature. To build confidence in the findings and increase the likelihood of identifying novel insights, all interviews were conducted by two researchers (Klein and Myers 1999).

<b>Table 1. Demographic Information for Interviewees (Junior Physicians)</b>				
<b>ID</b>	<b>Current role</b>	<b>Current unit (duration)</b>	<b>Prior experience in the same hospital</b>	<b>Prior experience in other hospital(s)</b>
1	Medical officer	Anesthesia and Surgical Intensive Care (7 months)	Nil	BPH (no CPOE)
2	Resident Physician	Anesthesia and Surgical Intensive Care (7 months)	Nil (permanent staff)	CPH (no CPOE)
3	Medical officer	Anesthesia and Surgical Intensive Care (1 month)	Nil	BPH, CPH, DPH, EPH
4	Medical officer	Accident and Emergency (2 months)	Yes	BPH
5	House officer	General Medicine (3 months)	Nil	CPH
6	House officer	Internal Medicine (3 months)	Yes, (no CPOE)	BPH, CPH
7	Medical officer	General Medicine (1 month)	Yes	BPH (no CPOE)
8	Medical officer	Anesthesia and Surgical Intensive Care (7 months)	Yes	BPH, CPH, DPH (no CPOE)
9	Medical officer	ENT (2 months)	Yes	BPH, CPH, EPH
10	Medical officer	Accident and Emergency (1 month)	Yes	EPH, FPH, GPH

<sup>2</sup> Two of the JPs were hired by the hospital hence they only rotated within the hospital. The other JPs have the option to rotate within and/or across hospitals.

11	Medical officer	Psychological Medicine (2 years)	Yes	BPH, HPH (ward based)
12	Specialist	Sports Medicine (contract)	yes (low extent of CPOE use)	BPH, EPH
13	Medical officer	General Medicine (9 weeks)	Yes	CPH, DPH
14	Medical officer	General Surgery (1 year)	Yes	BPH (no CPOE)
15	Clinical associate	General Surgery (6 months)	Nil (permanent staff)	Overseas (no CPOE)
16	Medical officer	GRM (1 month)	Nil	Overseas
17	House officer	General Surgery (7 months)	Yes	Nil
18	Medical officer	General Surgery (2 months)	Yes (no CPOE)	BPH, CPH (no CPOE)
19	Medical officer	General Medicine (2 months)	Yes	All other hospitals
20	Medical officer	Urology (1 month)	Yes	EPH
21	Medical officer	Cardiology (1 month, next posting still here)	Yes (no CPOE)	BPH, DPH (no CPOE)
22	Medical officer	Dermatology (1 month)	Yes	Nil
23	Clinical associate	Rehabilitation Medicine (2 months)	Nil	Overseas (no CPOE)
24	House officer	General Surgery (3 months)	Nil	BPH (no CPOE)
25	Medical officer	Accident and Emergency (1 month)	Yes	BPH, CPH, DPH
26	Medical officer	Cardiology (1 year)	Yes	BPH (no CPOE)
27	Medical officer	Eye (1 month)	Yes (no CPOE)	BPH, IPH
28	Medical officer	Accident and Emergency (3 weeks)	Nil	All other hospitals (such as BPH, DPH)
29	Medical officer	General Medicine (1 month)	Nil	CPH, EPH

Transcribed data was organized into a set of initial coding themes based on the data induction and supplemented by theoretical lens. Some sample themes that emerged include learning from previous experience, organization identification and system comparison. Interview

data was supplemented by data gathered from observations and related documents. Each finding was supported by at least two pieces of evidence (Klein and Myers 1999). Initial theoretical framework was further refined by moving back and forth between empirical data and theoretical lens. In the next section, we elaborate on the learning trajectory, including how each type of learning occurs, its impacts on assimilation outcomes, as well as how the individual learning influences the organizational learning. Following the interpretive approach (Dam 2005, Walsham 2006), we provide sample quotes to illustrate the JPs' viewpoints. The sample illustrative quotes are summarized in Box 1-7.

#### **4. ANALYSIS RESULTS**

Job rotation was found to affect JPs' identification with the APH and their situated learning. Social identification is the process by which individuals sense who they are based on their group membership(s) (Ashforth and Mael 1989). We found three factors influencing JPs' identification. First, most of the JPs in this study were part of a residency program managed by the Ministry of Health (MOH). Hence, they were employed by MOH instead of the hospitals they were rotated to. Some JPs associated their extent of identification with such employment relationship and hence identified with MOH (see quotes in Box 1, point 1). Second, instead of MOH as the actual employer, many JPs identified themselves with the hospital they spent more time with (see quotes in Box 1, point 2). Third, some JPs also felt that a good work environment gave them a greater sense of belonging (see quotes in Box 1, point 3). As revealed by the interview data, the extent of identification influenced the effects of JPs' situated learning on assimilation outcomes. Such effect will be depicted in the subsequent sections.

#### **Box 1: Illustrative Quotes on Social Identification**

1. **Employer** - "...we are all under MOH in general. We don't belong to a cluster or a hospital. It's clear cut to us that we don't belong to any hospitals." (JP#8)
2. **Tenure** - "...because I've worked here more, for a longer period of time, I think that over here I know the people slightly more and longer, so, the working connections here are definitely better than in EPH<sup>3</sup> where I was working for 4 months... definitely identify myself more with APH." (JP#20)
3. **Working environment** - "Everyone in APH has been nice enough to make me feel a part of the hospital and ya, let's say I feel like with family here." (JP#28)

#### 4.1 Individual Situated Learning of CPOE

Although all JPs received an initial formal training on the CPOE as part of their orientation in their new rotation, they generally felt it was inadequate and provided only an introduction to the system. The training contents were too general and focused more on the technicalities of the system such as how to make orders, instead of addressing the different requirements and usage of the different units (such as the terminologies required for making specific orders and where to find specific orders) (see quotes in Box 2, point 1). The JPs at APH were found to engage in situated learning. They felt that learning to use the system was a much more pervasive activity that went beyond the initial training, and required prior experience, hands-on practice, on-the-job learning, getting help from others and watching how others use the system (see quotes in Box 2, point 2).

#### Box 2: Illustrative Quotes on Situated Learning

1. **Training session was inadequate**
  - "Training session was inadequate, because there were just too many things you'll probably want to know and each department<sup>4</sup> uses different things. For example, certain cultures or investigations are particular for one department, even within surgery, let's say I'm in surgical hepatobiliary, I'll be doing certain markers, certain investigations. ENT uses EPT and things like that. There are different cultures like in theatre; we do different types of cultures. All these things require totally different inputs. You will not get to know everything from a one-hour training session" (Physician #8)
  - "During the orientation, they only introduce the system, we have to learn on the job

<sup>3</sup> Hospital name is masked to protect the identity of the hospital.

<sup>4</sup> Physicians in this hospital refer to *medical unit* as *department* hence we left the actual term in the interview quotations

itself...” (Physician #4)

- “Ya, they did arrange a training session. But I don't think they are very useful... The information provided mostly deals with technicality of how to make an order. But I think more importantly, the more difficult part is about finding the order that you want to order, it's not easy because there's specific terminologies that are used.” (Physician #17)
- ‘The course itself is only a half-day. Then it's only when you learn along the way then you familiarize yourself better...When I face any problem about using the system, I usually just play around with the buttons.’ (Physician #18)
- ‘The training is 2 hours or so. I don't think it's adequate. You just need practice, you know, you have to practice.’ (Physician #23)

## 2. **Situational learning**

- “Majority of the learning was on the job itself.” (Physician #4)
- “It was a lot of learning on the job, learning from experience.” (Physician #17)
- “I think it's only when you are using it for patient then you really learn from it... I needed some time to learn the system. At that initial phase, there are other people there to teach me how to use the system. They are mostly doctors.” (Physician #18)
- “At the end of the day we still have to play around with the system and figure out what's going on in the CPOE by ourselves mainly... basically just asking the people around how to use the system.” (Physician #20)
- “Training is definitely good to get you in terms with the system... but practice makes perfect. So the more you use it by yourself and from time to time you make mistakes...that’s how you learn. I mean you will not get to know everything from a one-hour session or training, but just to know the basics.” (Physician #28)
- “The session about both the lab and the system? Maybe about 2-3 hours. This kind of orientation was useful, but along with that because I was quite new to the system, after the talk, I spoke to many of my colleagues and when I was in the ICU I asked them to show me how to use. That’s how I learned.” (Physician #2)

Job rotations provided JPs with different CPOE experiences and medical knowledge. As units were responsible for care of different types of patients, JPs had the opportunity to pick up new medical domain knowledge when working in different rotations. Their CPOE experience also varied as some rotations may involve using a CPOE while others involve using paper-based ordering. CPOE systems also varied as prior rotations might involve using other CPOE systems or one similar to A-CPOE. Due to varying prior experiences, JPs experienced different learning trajectories and assimilation outcomes in using the CPOE when rotating to APH.

Figure 1 summarizes findings for different learning trajectories. For each learning trajectory, we explain relevant historical embeddedness (i.e., learning from experiences in previous rotations) and social/environment embeddedness (i.e., learning from current work environment), two key components based on situated learning theory (Lave and Wenger 1991). Based on the data, assimilation outcomes are classified into two major categories: 1) utilization of order sets; and 2) perceived benefits of CPOE. Physicians had the choice to use the order sets already in the system or use their own customized order sets. Common orders tend to vary across units. Some units like A&E had their own unit order sets while others relied on the order sets created by the hospital or other units. CPOE-related benefits are categorized into three types: benefits to JPs; to hospital; and to patients. Perceived benefits to JPs included reduced work burden, improved work efficiency and error reduction. Perceived benefits to hospital include improved process efficiency, enhanced monitoring, and easier auditing. Recognized benefits to patients include getting faster treatment and avoiding unnecessary investigations and costs.

### **Learning trajectory I – Repeat-based learning**

This learning trajectory arises from JPs who had experience with the APH CPOE (A-CPOE) in their prior rotations in other units of APH. It was a *repeat-based* learning process that leveraged mainly on their past experience with the A-CPOE.

**Historical embeddedness:** These JPs felt that their experience with A-CPOE helped shorten their learning curve of using the CPOE in the new posting as they knew “how to order”, “common investigations” (see quotes in Box 3, point 1).

**Social/environment embeddedness:** With prior experience of A-CPOE, JPs found the training to be unnecessary. These JPs noted their main focus of learning in the new unit was on

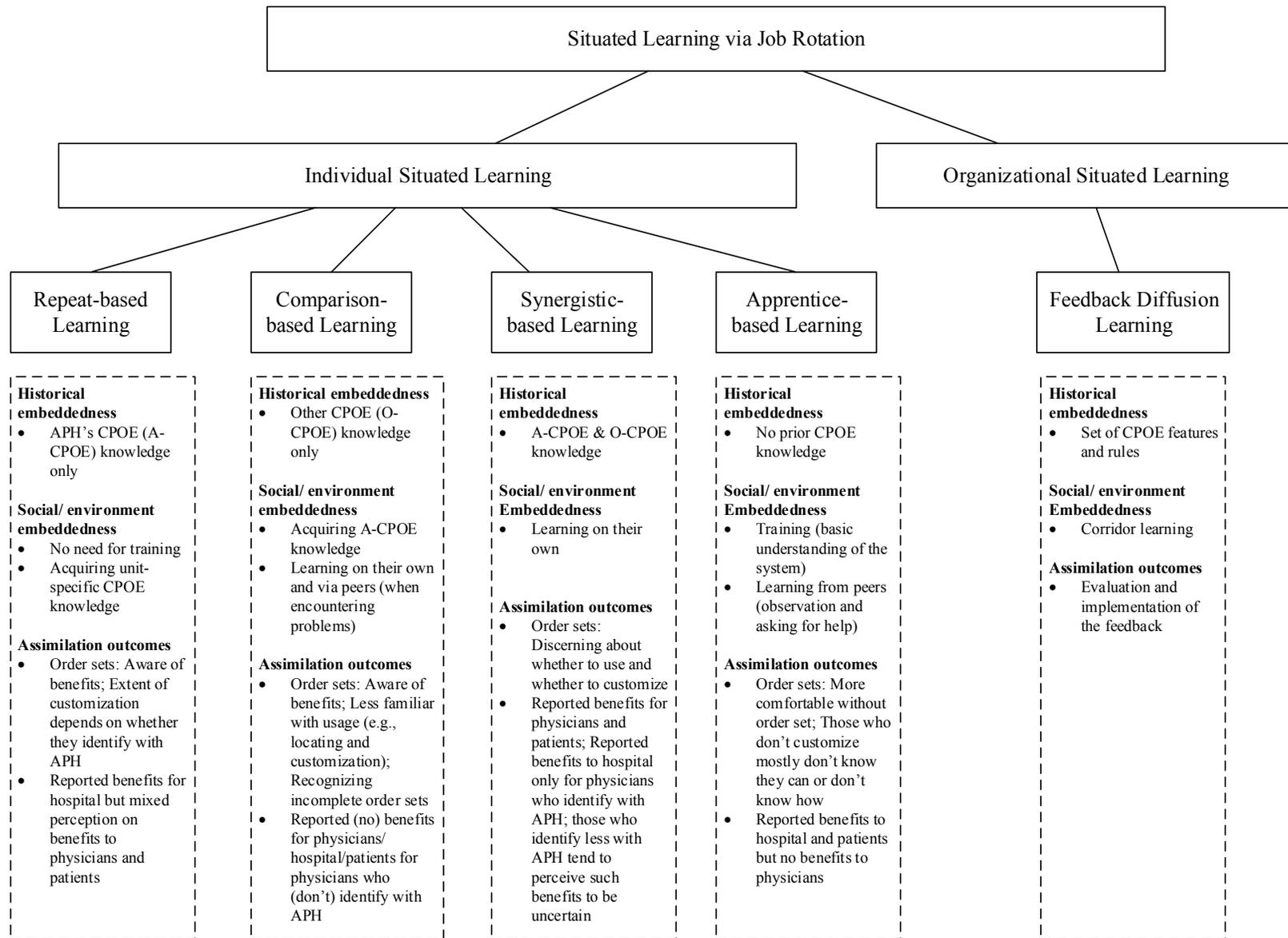


Figure 1. Summary of the Learning Trajectories

acquiring unit-specific CPOE knowledge (e.g., what types of tests to order and where these tests were in the CPOE) through practice and self-exploration (see quotes in Box 3, point 2).

**Assimilation outcomes – order sets utilization:** JPs in this category acknowledged that learning to use or customize the order sets required effort. Nonetheless, they found the order sets useful when most of the things (e.g. blood tests) they ordered were there and when there were many common orders to make (e.g. when patients have pneumonia which is very common in the unit) (see quotes in Box 3, point 3). Further, we found JPs who identified with APH (e.g. JPs #21,22,26) to create more customized order sets than those who were not (e.g. JPs #7,8,14,19).

**Assimilation outcomes – perceived benefits:** JPs with only A-CPOE experience were cognizant of how the CPOE benefitted the hospital management in terms of tracking and reducing resource utilization, improving efficiency and easing auditing. Having used the A-CPOE for a longer period, these JPs might be more aware of how the system had been fostered by hospital management. However, these JPs held a mixed view on whether the CPOE benefitted JPs and patients. While some acknowledged that CPOE could save time, help reduce mistakes and track orders in an organized manner hence benefiting patients, others felt CPOE work took more time and could be an additional burden that hindered patient care (e.g., less focused on patients) (see quotes in Box 3, point 4).

### **Box 3: Illustrative Quotes on Repeat-based Learning Trajectory**

#### **1. Historical embeddedness**

- “Experiences of working in the different departments in APH help better utilize the system for this posting. I know how to order. Some investigations are common across departments.” (JP#21)
- “I don’t need the training session anymore because I have learnt before...Once you get used to the CPOES, you know how to use it then there is no need for me to be trained again” (JP#19)

#### **2. Social/environment embeddedness**

- “I don’t need the training session anymore because I have learnt [the system] before...

Once you get used to the CPOE, you know how to use it then there is no need for me to be trained again.” (Physician #19)

- “Some investigations are common across departments. But for this posting, some orders are new and generally they are not very complicated.” (JP#21)
- “For my ward work in this posting, I don’t really know what order set I need to use.” (JP#26)

### 3. **Assimilation outcomes - order sets utilization**

- “I think order set is very useful because there are a lot of things, like suppose the patient come with pneumonia, which is quite common, and we tend to order common things. Of course there will be one or two extra investigations, which are for individual person. But nevertheless we know that there are some common things like infective markers or you know like blood cultures, things like stool for investigations, or urine for investigations. These are things, which are commonly done. So, it's useful because you just have to click on it rather than finding it again and again.” (JP#22)
- “I don’t use order set. I prefer to type for now because I switch hospital very often. But if it's long time the order set will be useful. Because you can just open up the order sets to order the sets.” (JP#19, identifies with MOH)
- “I created my own order set because I want it to be faster.” (JP#22, identifies with APH)

### 4. **Assimilation outcomes – perceived benefits**

#### ➤ **(Quotes on benefits to hospital)**

“The system is also good for hospital management. It makes things faster. So the result comes out faster and then we get to treat the abnormalities faster. Everything is basically just very fast and effective.” (JP#22)

“I definitely think the system makes the hospital management easy to audit and do proper documentation” (JP#17)”

#### ➤ **(Quotes on benefits to patients and doctors)**

“The system does not really reduce the error... but it will help you to get them together...it will help to consolidate record and eventually improve patient care.” (JP#21)

“It actually makes our discharge process very fast... if you finish it very fast then your patient gets to go home faster...The system definitely will add value to our work because we can concentrate more on the patient care and not so much on writing the name, or IC number. So, I find the CPOE has definitely reduced the time taken to actually do all the paper work and concentrate more on the patient's healthcare.” (JP#22)

#### ➤ **(Quotes on NO benefits to patients and doctors)**

“It's bad for patient because now we do not actually focus on the patient in this way. That's why I say the more amount of attention and amount of effort we put in to the system, how to make an order, that's not for patient.” (JP#17)

“The system doesn’t make a difference in term of making our work faster. Compared to paper form, probably CPOE takes a little bit longer time because we have to go and find out what, must look what we need and search for it.” (JP#21)

## **Learning trajectory II – Comparison-based learning**

JPs going through this learning trajectory only worked with other CPOE systems (O-CPOE) in prior rotations. They tend to refer to O-CPOE when learning the current system. Hence we term this as a *comparative-based* learning process.

**Historical embeddedness:** Relative to those with prior knowledge of A-CPOE, JPs who only worked with O-CPOE experienced greater difficulty in using the A-CPOE in their current rotation. While learning to use a different CPOE was not as easy as compared to having used a similar system, JPs found their prior exposure to O-CPOE helpful in learning to use the A-CPOE as they already had the basic idea of using CPOE, and just needed to know the nuances of the A-CPOE (see quotes in Box 4, point 1).

**Social/environment embeddedness:** While some differences were found between the different CPOE packages such as the user-interface and outputs of the system, these JPs generally felt the basic system functions were the same (e.g., making orders). When learning to use the A-CPOE, they could navigate and explore on their own. When encountering problems, they would ask colleagues (nurses or other physicians). However, they tended to use their prior experiences and knowledge of O-CPOE to compare and evaluate the current A-CPOE (see quotes in Box 4, point 2).

**Assimilation outcomes – order sets utilization:** JPs who had prior O-CPOE experience found the order sets beneficial. They felt the order sets reduced the time to scroll through and search for things. Instead of typing out each order, they could click the orders to select the options they wanted. However, without A-CPOE experience, some JPs also found some of the order sets hard to locate and incomplete, but their experience with O-CPOE gave them the ability

to make comparison and discern that the order sets were incomplete (see quotes in Box 4, point 3).

**Assimilation outcomes – perceived benefits:** JPs with only O-CPOE experience showed more positive perceptions of system benefits if they identified more with APH than if they identified more with other hospitals or the MOH. JPs who identified themselves with APH expressed a better sense of membership and oneness with the hospital, which motivated them to be more appreciative of the hospital’s initiatives<sup>21</sup>. Hence they were more likely to see the benefits of the A-CPOE than those who had a low sense of identification with APH (see quotes in Box 4, point 4).

#### **Box 4: Illustrative Quotes on Comparison-based Learning Trajectory**

##### **1. Historical embeddedness**

- “The experiences of using different CPOE help me because the ordering part is almost the same as what we had... So, it did not come to me as a new thing. But ya, the results and the trends and the individual results you can pick up. Those things were a bit new.” (JP#16)
- “If you come from hospitals that are using the same system, it’s easier... It’s harder if you are coming from a hospital that uses a different system.” (JP#28)

##### **2. Social/environment embeddedness**

- “The systems are roughly the same. This side is a bit more confusing. We have more blood tests and we have radiology as well. So, sometimes the options can be a little confusing but I think it’s still pretty easy to get the hang of it. The basic system is already the same... It’s just this additional step [user interface] which is not too difficult to learn actually.” (JP #27)
- “Because I use the other system before, I know, I find there are more difficulties in using this system because there are certain things that should be there [but] it’s not there, and certain things shouldn’t be there [but] it’s there.” (JP#29)

##### **3. Assimilation outcomes - order sets utilization**

- “The order set cuts down the time to scroll through and search for the things we need. So it becomes helpful in terms of minimizing time we have to go through the option.” (JP#3)
- “Most of the things that we order are found there... it’s kind of easy rather than you go type one by one what you want. When you go there, if you want 3 investigations and yet all 3 of them are on the same page, you just click, click, click, then print out rather than type in one and then type in next one.” (JP#28)
- “Yes, I love the order set but then sometimes, the order set is not very easy to find, it is

good if the order sets are more accessible, so that we can find them.” (JP#5)

#### 4. **Assimilation outcomes – perceived benefits**

##### ➤ **(Quotes on benefit to physicians)**

“The CPOE minimizes errors because it is electronic, so issues like handwriting, loss of orders, wrong stickers, wrong patient labels are minimized.” (JP#3, identifies with APH)

“The system is also very easy for me to write memos, and all documents are documented and are chronologically ordered...” (JP#5, identifies with APH)

##### ➤ **(Quotes on NO benefit to physicians)**

“I think it is no value to physicians because it does not make any difference. Burden wise, yes. An example is when I want to do a particular investigation, e.g., CT blood vessels angiogram. The system gives me an entire list to choose from. It happens before that one doctor made a wrong selection because there are just too many almost similar selections to choose from and sometimes we might end up ordering the wrong scan. So no one noticed and the appointment was made. Because the order was wrong, it was rejected. At the time it came back and we reordered, there was a lot of time wasted. You cannot type free text for what you want to order (you have to select from a pre-list which was already there). Usually the department that you order to (radiologist) will call to confirm if there is what you really wanted to order, the nurses will feedback accordingly. That’s the only way we can get feedback. All efficiency goes down.” (JP#1, does not identify with APH)

“If the whole system becomes more efficient, it can be more beneficial. But I don't think the system reaches that level yet.” (JP#27, identifies with BPH).

##### ➤ **(Quotes on benefit to hospital)**

“[For] the hospital, because there are proper documentations, and we have to save our work before we can print out anything to finalize, so that is a form of checking. As for management, they can also keep a better tab on the things that are happening.” (JP#5, identifies with APH)

##### ➤ **(Quotes on no benefit to hospital)**

“It is not apparent to me that the system is helpful towards the hospital or patients in any way.” (JP#, does not identify with APH).

##### ➤ **(Quotes on benefit to patients)**

“The CPOE is beneficial. I mean it is quicker in terms of getting treatment because we know what happen to them in the past. And if it is the same problem it's easy to treat them.” (JP#28, identifies with APH).

##### ➤ **(Quotes on no benefit to patients)**

“I don't think the system is beneficial to the patient. Even, in manual forms the tests are still done, so it doesn't really affect them.” (JP#29, does not identify with APH).

### **Learning trajectory III – Synergistic-based learning**

Some JPs had both knowledge of A-CPOE and O-CPOE. These JPs used the A-CPOE at their previous rotation at APH and O-CPOE during their rotation(s) at other hospital(s). Their learning process was *synergistic-based* where they made use of their rich CPOE knowledge to perform their work, as well as to identify new opportunities for improving the A-CPOE through alternative functions or work processes.

**Historical embeddedness:** These JPs had rich CPOE experiences and most deemed the learning process to be easy. Having used A-CPOE previously, they were already familiar with the basic set of functions in A-CPOE. Knowledge of O-CPOE further complemented and deepened their judgment by providing knowledge of alternative functions or work processes learnt earlier (see quotes in Box 5, point 1).

**Social/environment embeddedness:** In their current posting, they tended to learn the current system by figuring it out on their own. When facing problems, they were familiar with the sources of support (see quotes in Box 5, point 2).

**Assimilation outcomes – order sets utilization:** JPs with both A-CPOE and O-CPOE experience were found to be discerning users of order sets. While these JPs were cognizant of the benefits of order sets such as the ability to order a new panel for a new patient without having to type, they pointed out that order sets were not always suitable. In cases where not all the tests in the order set were needed, the use of order set might incur more time as they would need to go through all the items in the order sets and click on what were required. For these JPs, using the order sets was not so much about learning how to use them but how to use them in appropriate situations. For JPs who had both A-CPOE and O-CPOE experience, some of them chose to not customize order sets, not because they were not aware of the customization ability but because

they cogitated more on whether customizing order sets was necessary for their work (see quotes in Box 5, point 3).

**Assimilation outcomes – perceived benefits:** JPs with prior A-CPOE and O-CPOE experience demonstrated deep understanding toward the CPOE. They unanimously recognized the benefits of CPOE for their work (e.g., improving work efficiency and reducing human errors) and patients (e.g., reducing costs). However for benefits to the hospital, those who identified with APH acknowledged the benefits for the hospital whereas those who did not identify with APH reported they were uncertain about such benefits (see quotes in Box 5, point 4).

### **Box 5: Illustrative Quotes on Synergistic-based Learning Trajectory**

#### **1. Historical embeddedness**

- “One thing with the CPOE is the one which we are using in [APH] is like ... we have to go to HIS or EMR. Working in some other hospitals is much easier there. Here you have to go through HIS and then you have to go to summary... So, there [other hospital] you can do that just directly and other than that all those radiologists can directly go to IMS from CPOE... Previous x-rays and all things have been done are there. Here [in APH], you can just see the report. And some systems are even more advanced like CPH where they even upload ECG’s also so you can see online your ECG result.” (JP #10)
- “[prior experience with APH and other systems] is helpful. You just practice. I mean as you use, you know how it happens.” (JP #25)
- “Once you switch over it will be a bit different but not so much on CPOE – quite general... [for my] first time, it took me some time [to learn the system]. But this posting, it is familiar.” (JP #13)
- “The two hospitals have the same system, but they don’t have all the same functions. When I was in another hospital, I thought they lack order set. So this is something they required.” (JP #4)

#### **2. Social/environment embeddedness**

- “During my first posting here, I was not familiar with the system and it took me some time to get used to it. Right now, since I did my last post over here which was a few months or year back, I'm ok with the system... Once you adapt to one system, it’s easier for you to adapt to a new system... Now I'm very used to it...” (JP#10)
- “Here was no initial experience for me, because I used the system previously. There was no impressive difference between the two systems, because I knew how to use. I don’t think I have to ask for support.” (JP #4)
- “If we face some problems, usually we'll ask the staff nurse who is also using the system. So, they are on the ground, they use it more often. So, usually they would know what to do. However, if they do not know then we'll call the ISP people and ask them to assist us

in what to do. Usually we use the system alone. Occasionally we'll run into problems because the computer will not be switched on because we just got new computers in, the mobile computers. So, that one we had a bit of problem so we need to call the ISD... Sometimes we couldn't re-print the CPOE forms or we don't know how to do it, so we have to get them to come out and sort that out. But other than that it's just among colleagues who attended the briefing on how to run the system then we just try and error among ourselves and just get by.' (JP #11)

### **3. Assimilation outcomes - order sets utilization**

- “I need to go through individual investigation because some things are not needed ... But sometimes it can be useful. So it depends from situation to situation. Sometimes like, some particular patient you just use the order set you will save a lot of time... Otherwise you have to click for each and everything. So, definitely order sets are helpful for certain cases.” (JP#10)
- “It [order sets] does help especially if you are doing let's say in the wards. But, in the clinical setting when we are in the patient setting, you don't really want to order everything, it's more specific. So, that's the reason why I tend to use specific investigations rather than order sets.” (JP#12)
- “The thing is I'm not going to stay here for very long, right? So, that's why. If I'll stay here for a longer time, then I can use all those innovations. For me, it's like just another few more months and then finish it up and go to another system.” (JP#10, customized once only)
- “We can use the order set or we can even do our own order set. We can actually customize our own order set. So, whatever that we feel that is more relevant in our daily work, we can actually do that also. So, that will be faster and more useful.” (JP#11, created a few order sets)

### **4. Assimilation outcomes – perceived benefits**

- **(Quotes on benefit to physicians)**
  - “You see, it is beneficial. Suppose a patient has come in with some particular problem and if I go to the system and can find out what medicines he's on, what is his past record, all those things, I can save my time in doing unnecessary investigations. And then I can be very focus on why this patient has been having this problem.” (JP#10, identifies with APH)
  - “I think it's quite good, quite fast. As long as it doesn't hang it helps.” (JP#25, does not identify with APH)
  - “The CPOE is not a burden. It's quite good. You can track the result in the computer. It's beneficial.” (JP#13, does not identify with APH)
- **(Quotes on benefit to patients)**
  - “Previously when we order on paper, there's no record on the system. So, we do not know whether we are repeating the same thing or we have never done certain investigation. And if we are repeating certain things like CT scan and everything, it might be at the cost of the patient. They have to pay double, you see. But with this system, we can actually be quite sure, what is ordered at what day, what is done at what day. So, we can actually go back and trace it rather than re-do it again...” (JP#11, identifies with APH)

I don't think it will harm them (patients). No. I think it will benefit them indirectly because we are in view of their result and it will help us reduce missing things like getting their results.” (JP#13, does not identify with APH)

➤ **(Quotes on benefit to hospital)**

“The hospital management can trace how much resources they use, and they can monitor usage as well. For example in A&E especially they like to make sure the patients have no critical condition. So they can monitor how much investigations they use.” (JP#4, identifies with APH)

➤ **(Quotes on being uncertain about benefit to hospital)**

“[Beneficial to the hospital management?], I don't know about that management.” (JP#25, does not identify with APH)

“[Beneficial to the hospital management?], I'm not too sure about that. If it's any use.”(JP#13, does not identify with APH)

### **Learning trajectory IV – Apprentice-based learning**

This learning trajectory arises from JPs without any historical CPOE knowledge. Their learning process was *apprentice-based* as they relied on training, observing how senior colleagues used the system and asking colleagues to show them how to use the system.

**Historical Embeddedness:** These JPs did not have any prior CPOE experience. They could be new to the rotation program or from hospitals without a CPOE.

**Social/environment embeddedness:** The A-CPOE was their first experience in using CPOE. For these JPs, the training served as an important springboard. They also sought help from information systems department specialists for technical issues and colleagues or staff-nurse for the daily ordering issues or problems (see quotes in Box 6, point 2).

**Assimilation outcomes – order sets utilization:** these JPs typically did not know the standardized investigations for particular illness. They shared that they were not aware of the ability to customize their own order sets. JPs would not be able to use their customized order sets once they were rotated out to a new unit, particularly to a different hospital. This created inertia toward using the order sets or customizing order sets. Indeed, JPs commented they would be

willing to learn how to create and use customized order sets if they need not to be rotated out (see quotes in Box 6, point 3).

**Assimilation outcomes – perceived benefits:** JPs with no prior CPOE experience appeared to have lower perception of system benefits to themselves as they were still trying to iron out teething issues associated with using the system (e.g., shortage of working computers). Surprisingly, despite the burden of the system on their work, this group of JPs was able to discern the benefits to the hospital (e.g., monitoring) and patients. In particular, whether patient benefits was said to be contingent on how the system is being used (see quotes in Box 6, point 4).

#### **Box 6: Illustrative Quotes on Apprentice-based Learning Trajectory**

##### **1. Historical embeddedness**

Nil.

##### **2. Social/environment embeddedness**

- “Training was quite essential because it still gives you basic understanding of the whole system.” (JP#18)
- “We need the basic introduction to the system. But subsequently it’s on the job.” (JP#14)
- “After the training, I spoke to many of my colleagues. I asked them to show me how to use. That’s how I learned... Colleagues can be anybody. Sometimes the X-Rays, I’ll ask the nurses; and the labs, my other colleagues. Now, if there is a problem, I will call my secretary and she would call the guys who are in-charged.” (JP#2)
- “Because I’m not a computer person. So, initially it’s hard for me to learn. It takes me some time. So, in the computer. I think I observe first for my first few days, observe first how is it doing. And then we did some orientation. They did some orientation to us, the newcomers. Then, later they allowed us to do. When we got the password and other things, so we started to do. When I start to use the system, there are other MOs who have been here for a while. You are free to ask them, and they are helpful to help you, help me.” (Physician #15)
- “My colleagues were with me for the first time coaching me... My colleagues know more about the tests. On the technical side, the IT people can show you which part to click, but for that detailed test, my colleague knew how to look for it.” (JP#23)

##### **3. Assimilation outcomes - order set utilization**

- “No. I don’t know how to create customized order sets honestly. If somebody will teach me, I will...” (JP#15)
- “No, I don’t even actually know that I can create my own order set” (JP#28)

- “From the first day onwards it's like just start doing work. So I don't really have the time to sit down and make my own order set or whatever.” (JP#24)
- “I'm just more comfortable with typing it one by one... if [I] do not need to rotate out of APH, I'll try the order set.” (JP#18).

#### 4. Assimilation outcomes – perceived benefits

- **(Quotes on NO benefit to physicians)**  
 “In the past when we use hard copy forms, I think it's easier. The hard copy form is always readily available either inside the case notes or at the nurse counter. Whereas when you CPOE, you need a computer ... I mean there are computers in the ward but not all computers are working. Not all computers are fully charged with the battery, so you can't push it around. And if there are a lot of teams doing the same ward, there'll be shortage of computers, so we can't order it. So, that's the frustrating portion.” (JP#18)
- **(Quotes on benefit to hospital)**  
 “[Beneficial to the hospital?] In a way, yes. Everybody knows who orders what, there'll be no confusion. If you order something then some radiologist pick the scan or procedures wrongly then you know and you can say that “yes, this is what you did wrongly” [something] like that.” (JP#24, does not identify with APH)
- **(Quotes on benefit to physicians)**  
 “For the patients, ya, it should be beneficial to them because they are the ones we key in for. If it's used in a proper manner then it should be beneficial to the patients. If we ensure right, the team ensures that it was ordered, then we expect it would be carried out. But, because sometimes the nurses don't go on rounds with us. We just do the rounds by ourselves. We need to communicate to them, we ordered something, please carry out. It actually takes communication.” (JP#23)

## 4.2 Organizational Situated Learning of CPOE

According to Lave and Wenger (Lave and Wenger 1991), communities-of-practice can be reproduced via learning from new comers to the community. It is also evident from the case that job rotation practice facilitates APH to reproduce its knowledge about the CPOE through *feedback diffusion* trajectory.

### **Learning trajectory V – Feedback diffusion learning**

**Historical embeddedness:** The features and rules of using CPOE were defined in APH.

Such knowledge was transferred to JPs through the training session during their orientation

period. The training contents focused more on the technicalities of the system such as how to make orders (see quotes in Box 7, point 1).

**Social/environment embeddedness:** Systems improvement occurred through feedback from users. However, at APH, many JPs did not provide any feedback to the hospital either due to the lack of time or knowledge of whom to give feedback to, or because they had no issue with the CPOE. Our interview with hospital management showed that APH did not have formal feedback mechanism for CPOE. The physician project lead for the CPOE project acknowledged that the information related to CPOE improvement was gathered through the form of “corridor learning”, through which JPs informally provided system-related feedback (see quotes in Box 7, point 2).

In our interviews, JPs were asked for their suggestions on improving A-CPOE so we could understand the type of feedback JPs could provide. Our findings showed that feedback varied across JPs with different CPOE experience. JPs with A-CPOE experience provided a list of items not currently included in the system to obviate the need to search for these items. Other suggestions included providing acknowledgement (through a printout) of cancelled orders to avoid cancelled orders being performed (see quotes in Box 7, point 2).

A benefit of rotating JPs with prior O-CPOE experience was that these JPs were able to provide suggestions based on their prior experience with O-CPOE. From interviews with JPs with only O-CPOE experience as well as JPs with both A-CPOE and O-CPOE experience, we found these JPs tended to compare A-CPOE with O-CPOE. They were able to identify the weaknesses of A-CPOE and suggested ways to improve the system. For example, one physician suggested making it easier to access the X-rays and to enable resizing of the images based on his experience from another hospital. Another physician who suggested to update the list of blood

tests investigations, cited the other CPOE he used having a more comprehensive list and hence reducing the need for manual paper orders. Job rotation thus had the benefit of facilitating knowledge transfer from one hospital to another (see quotes in Box 7, point 2).

JPs without any prior CPOE experience were less likely to provide in-depth suggestion to improve the system. Their feedback was mainly based on the work at hand such as certain tests were not included in the current CPOE or order sets (see quotes in Box 7, point 2).

**Assimilation outcomes - evaluation and implementation of the feedback:** Feedback from physicians were first evaluated by the CPOE project lead for feasibility (e.g., benefits and cost). This scrutinized feedback will then be submitted as formal proposals for budget allocation and only implemented if the budget was obtained. An example of such an implemented feedback was the feature to check for renal impairment for CT scans (see quotes in Box 7, point 3). This feedback came from some physicians after frequent complaints from the lab technicians that they had to repeatedly verify this need with the physicians, which resulted in delayed or canceled scans. This feature saved the physicians' and lab technicians' time and made the workflow better. It also improved the overall CPOE system. However, the physician project lead for the CPOE project shared with us that such feedback from physicians was not frequent. This could partly be due to the lack of formal mechanisms to provide feedback. There was also a tendency to solicit feedback and opinions from recipients of information from the CPOE system (e.g. the radiologists, technicians, etc. who need the information to perform the orders). This ensured that the CPOE system was designed with the right order templates for physicians. This could explain why less feedback had been obtained from physician users although these users did have useful feedback from their rotation experiences that could be useful to improve the CPOE.

#### **Box 7: Illustrative Quotes on Feedback Diffusion Learning Trajectory**

## 1. Historical embeddedness

- “The information provided [by the hospital] mostly deals with technicality of how to make an order.” (Physician #17)
- “Training was quite essential because it still gives you basic understanding of the whole system.” (JP#18)

## 2. Social/environment embeddedness

### ➤ (Quotes on corridor learning)

“There is no formal mechanism to elicit physician feedback. Most feedback comes from physicians who bump into me and tell me what is missing and what they wish could be included into the CPOE.” (the Physician Project lead for the CPOE project)

“No [feedback provided], because we have no time or it’s quite difficult to get them.” (JP#5)

“No [feedback provided]. I don't know who to give to.” (JP#29)

### ➤ (Quotes on suggestions to CPOE – with prior A-CPOE experience)

“Sometimes certain names of the test are under different parts of names. For example, if you want to order a blood test called pro-BNT. We usually call it BNT or BNP. But, we need to check its original name which is NT-BNP will show up on the system. And sometimes nobody knows that it's on that system...A lot of the smaller, all the rarer viruses and all, they are not in the system. So, it's a problem when we treat the patients. I guess, we probably need to have a list because nobody knows. When you call, they will say they don't know and they say to use manual form. But, you don't know whether it's not in the system because you can't find it or because it's really not in the system...it should be improved... Maybe have a list of tests that are not in the system.” (JP#21)

“When we order, it gets printed out. I find it is weird that when we cancel it, there is no print out. I know it's a waste of paper. But if we don't print out the cancelation order, sometimes they don't know that the order has been canceled... Many times I have encountered that when we cancel the order that we don't want to carry out the investigation anymore, it is not acknowledged by the person who is actually carrying out the order, like the nurses or the phlebotomist. So sometimes they end up doing it anyway which is again a waste of resources.” (JP#22)

### ➤ (Quotes on suggestions to CPOE – with prior O-CPOE experience)

“Some parts of the CPH system are actually better. I feel that the x-ray system at CPH is much more user friendly. I can navigate and play around with the CPH system easily. The x-rays [here], I think it is not easy. It is easier to put the x-rays to where I want them, better get the size of the x-rays, like to magnify or shrink.” (JP#5, O-CPOE knowledge)

“I think in terms of test wise actually less than that of the EPH. Meaning the blood test, it's not as comprehensive. So, my suggestion will probably be to update the CPOE in terms of the blood test investigations in the hospital because there are some tests in which we still have to do the forms manually.” (JP#20, A-CPOE and O-CPOE knowledge)

“Patient could have different kinds of complaints we always have to enter the reason we

are entering the order. For example when we are ordering some kinds of test, for example for chest pain, high pressure. Sometimes, after certain types of tests, we still have to re-enter same kind of complaints every time. I think it would be appropriate if it could be modified so we don't have to enter complaint all the time.” (JP#4, A-CPOE and O-CPOE knowledge)

➤ **(Quotes on suggestions to CPOE – without prior CPOE experience)**

“I feel that it's not really complete. Some tests are still not available, I mean in the choices. So, we still have to go do manually for some. So, I don't know whether it's still evolving or are (they) going to update or whatever I don't know.” (JP#23)

**3. Assimilation outcomes - evaluation and implementation of the feedback**

➤ “When I get the suggestions, I will first check whether it is feasible and possible. Then look at the costs and benefits. If I think it’s worth doing then I will put up a formal proposal to request for budget to add the feature.” (CPOE Physician Project lead)

➤ “For CT scans that require contrast, there is a risk of causing kidney injury, more so for patients who have pre-existing kidney problems. So when a user orders a CT scan, the system was requested to check if there was a renal function test (in particular eGFR) done recently (within 3 months). If there was no result, the user will be prompted to order the test; if there is a result and it is normal, the order proceeds, if the result shows renal impairment the user is advised to consider doing other scans or taking some preventive / protective measures prior to the scan.... This was something to help their workflow. Often times IT is asked by one group of users to ‘force’ or prompt another group of users to do certain tasks. This is really not ideal but sometimes it is required because the second group of users rotate or are junior and need the prompting... but in this case the feedback was from the Doctors but it is likely based on complaints from the Technicians....usually users request for pre-fills which we do via order sets which lump orders together and pre-fills some of the information to save them time. We evaluated the need, as well as the cost (both in terms of dollar and effort) as well as the cost in terms of system slowdown, and then decided that it would be implemented.” (CPOE Physician Project lead)

## **5. DISCUSSION AND CONCLUSION**

Understanding and ensuring success in IS assimilation is critical to originations. In hospitals, job rotation is a necessary and an important part of physicians’ medical training. As the use of HIT becomes a central part of physician work, it is imperative to understand how job rotation can affect the assimilation of HIT for physicians and healthcare organizations. Using situated learning lens to analyze the job rotation experiences of JPs in a hospital, this study identifies the

different forms of situated learning that occurs during system assimilation at the individual and organizational level and the different assimilation outcomes associated with them. Below we highlight three important contributions this study makes to the literature.

First, this study complements prior literature on IS assimilation by providing a new lens to examine system assimilation within the context of job rotation. Prior studies generally follow the assumption that users' knowledge on IS grows along with the duration of the system assimilation in the organization (Bala and Venkatesh 2013, Deng and Chi 2012, Kang et al. 2012, Leonardi 2013, Li et al. 2013, Liang et al. 2015, Morris and Venkatesh 2010, Sun 2012, Sykes et al. 2014, Tong et al. 2015). Hence, the key objective is to support users in the initial phase and assimilate the technical features of an enterprise system into the business routines so that the expected benefits of the system can be actually realized. Our findings show that the rotating nature in the hospital context may challenge the appropriate system assimilation by physicians even when a HIS has been implemented for a long time. When physicians are transferred into a new hospital or hospital department, they have to acquire system-specific or department-specific knowledge of the system to be able to use them in their work. At the organizational level, system assimilation occurs when new system features and usages that are introduced based on feedback from users are diffused across the organizational work processes and become routinized in the activities of those processes (Purvis et al. 2001). This finding complements the punctuated equilibrium view where IT application use has been observed to reflect patterns of routine use punctuated by episodes of change activity (Lassila and Brancheau 1999, Majchrzak et al. 2000, Tyre and Orlikowski 1994). Prior to our study, job rotation as a source of such change has not been studied in the existing literature.

Second, by identifying the different learning trajectories of rotating physicians in HIT assimilation, we demonstrate how situated learning theory could be an appropriate lens for understanding system assimilation in job rotation contexts. This study shows that a physician's system learning process is not isolated from the environment. Rather, historical experiences and current work practice do play substantial roles in the learning process. While prior literature on IS use has studied the role of system support structure (e.g., Sykes 2015) in individual adaptation right after system implementation, they have not explored how prior experiences will influence the support structure used. More specifically, our study shows that different support structures are necessary depending on user's prior system and work experience. This is in line with other studies (Tong et al. 2015) that have suggested that a discriminating approach to providing support structures is necessary.

Third, this study advances the job rotation literature by extending boundaries used in the previous literature. While previous studies consider job rotation as an intra-organization strategy (e.g., Arya and Mittendorf 2004, Campion et al. 1994), the context of this study suggests that rotation can also be employed across the organizational boundaries. Findings of our study showed that previously identified benefits of job rotation, e.g., enhanced job commitment and job satisfaction, may not hold when an individual needs to rotate among different organizations. In particular, advanced system use (or order sets) and reported benefits of the system were contingent on physicians' extent of identification with the hospital.

There are several limitations to this study. First, interview data, as the major source of data in this study, was collected retrospectively. While we ensured that the findings were supported by multiple evidences (Klein and Myers 1999), a longitudinal approach could be adopted to capture the entire learning process. Second, the research findings were generated

based on the case research methodology. Quantitative studies can be conducted to statistically verify the relationships identified in this study.

Our findings yield important implications for practice. First, hospital management should be aware that the success of a HIS lies in the effective use by physicians and can be challenged by the strategy of job rotation. To the extent that many physicians may only stay in the hospital for a limited period, supporting resources need to be constantly provided to facilitate the learning by those rotating physicians. Second, based on our findings, physicians with different rotation experiences may go through different learning processes. Hence, hospital management can categorize rotating physicians based on the experiences and tailor the supporting strategies accordingly. For instance, for physicians with experiences in multiple hospitals, the hospital management should pay particular attention on improving their organization identification, e.g., proactively organizing social events. Through this way, a physician's learning can be fostered. Third, the results of this study may also be useful for policy makers to design a better rotation schema. Given the increasing attention paid on HISs, when designing a rotation schema, policy makers could also take the impact of rotation on HIS success into consideration. For instance, to the extent that diversified system knowledge could broaden a hospital's knowledge pool, when selecting JPs in a hospital, priority can be given to those who have experiences in using comparable systems.

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## APPENDIX

**Table A1 Related literature on IS Assimilation**

Source	Assimilation Stage	Users' Knowledge about the system	IT systems Implemented	Method	Research Focus and Key Findings
Bala and Venkatesh (2013)	Shakedown phase (Immediately after the rollout) T0: immediately before training T1: within a month of training T2: 2 months after T2 T3: 3 months after T2	Low <i>(Evidence: when employees start using the system, they have to spend a significant amount of time learning the new software. Employees are likely to make mistakes when using the new system.)</i>	SAP, ERP systems	Longitudinal field survey(6 months) <i>Sample:</i> 281 employees and 141 employees from two organizations	<b>Focus</b> Changes in employees' job characteristics following an enterprise system implementation. <b>Key findings</b> <ul style="list-style-type: none"> <li>• During shakedown phase, employees felt a significant increase in job demands and decrease in job control.</li> </ul>
Wang et al. (2013)	Early stage (7 months after the implementation)	-	Knowledge management systems (KMS)	Time-series cross-sectional data <i>Sample:</i> 499,296 computer-recorded KMS usage data on 83,216 employees of a management consulting firm	<b>Focus</b> The impact of two key social influence mechanisms (identification and internalization) on the growth in individuals' use of KMS. <b>Key findings</b> <ul style="list-style-type: none"> <li>• Subordinates' prior use influenced subjects' system use for all employees who had subordinates.</li> <li>• Peers' prior use significantly influenced subjects' system use for lower-echelon employees only.</li> </ul>
Sykes et al. (2014)	Early stage T0: 5 months	Low <i>(Evidence: the</i>	ERP system	Online survey <i>Sample:</i> 87	<b>Focus</b> The effect of workflow and software

	prior to the implementation T1: Immediately after the roll-out T2: 6 months after the implementation	<i>software advice network is very important to aiding in accomplishing one's job, especially in the early stage of an ES implementation)</i>		employees from a large multinational telecommunications company.	get-and give-advice networks on post enterprise system implementation job performance. <b>Key findings</b> <ul style="list-style-type: none"> <li>Workflow advice and software advice are associated with job performance.</li> </ul>
Liang et al. (2015)	Exploration usage (3.67 average years after ERP implementation; the minimum time since implementation is 2 years)	Rich (Evidence: <i>employees are able to adapt the system in various ways to better accomplish their tasks; and can discover and re-create meaningful applications to enhance their productivity...</i> )	ERP system	Field survey Sample: 221 employees from six Chinese firms	<b>Focus</b> The impact of task characteristics, system complexity, and innovation climate on employees' system exploration. <b>Key findings</b> <ul style="list-style-type: none"> <li>Job autonomy and task variety directly enhance system exploration.</li> <li>System complexity strengthens the relationship between job autonomy and exploration and weakens the relationship between task variety and exploration.</li> </ul>
Maruping and Magni (2015)	Post-adoption phase T1: 1.5 months post-implementation T2: 13.5 months post-implementation)	Low (Evidence: <i>individual team members need to explore the technology's features to fulfill their work activities...</i> )	Collaboration technology	Field survey (12 months) Sample: 212 employees in 48 organizational work teams from two large firms	<b>Focus</b> Examine how the team environment promotes sustained exploration of collaboration technology by individuals in team settings. <b>Key findings</b> <ul style="list-style-type: none"> <li>Team empowerment having a positive cross-level influence on intention to continue exploring and expectation to continue exploring.</li> </ul>
Stein et al. (2015)	Continued use stage	-	Productivity software	Case study (47 semi-structured	<b>Focus</b> The role of emotions in how specific

			package implementation in university	interviews)	IT use patterns emerge. <b>Key findings</b>
					<ul style="list-style-type: none"> <li>• Four classes of affective responses elicited by an IT stimulus event: loss, achievement, deterrence, and challenge emotions.</li> <li>• Five types of affective cues of IT stimulus event: IT instrumentality, interactions with others, involvement in change, identity work, and IT symbolism.</li> </ul>
Sykes (2015)	Shakedown phase T1: 5 months prior to rollout T2: 3 and 6 months after rollout of the system	Low <i>(Evidence: in the shakedown phase, given the introduction of new processes and software, employees are most in need of help to cope and adapt...)</i>	ERP system	Survey Sample: 120 supplier liaisons from a single business unit of the organization	<b>Focus</b> The impact of four traditional support structures (i.e., training, online support, help desk support, and change management support) and peer advice ties on employee outcomes. <b>Key findings</b>
					<ul style="list-style-type: none"> <li>• Peer advice ties and traditional support structure were shown to influence system satisfaction, job stress, and job satisfaction.</li> </ul>
Tong et al. (2015)	Swift response phase T1: 1 month after the system implementation T2: 1 month after T1	Low <i>(Evidence: in the swift response phase, users tend to undergo a steep learning curve and struggle with the basic system functions.... )</i>	A closed-loop medication management system in a public hospital	Two-stage survey Sample: 329 nurses at a focal hospital	<b>Focus</b> Examine how organizational support structures can facilitate different types of IS use-related activities to enhance performance in the swift response phase (SRP). <b>Key findings</b>
					<ul style="list-style-type: none"> <li>• Neither standardized system use nor nonstandardized system use has a significant direct effect on performance in the SRP.</li> <li>• Support structures in SRP have a</li> </ul>

Bala and Venkatesh (2016)	T0: pre-implementation (before the training) T1: 1 month after T0 T2: 2 months after T1 T3: 3 months after T2	Rich <i>(Evidence: Exploration-to-innovate is a problem-focused adaptation because employees will proactively be involved in discovering new features and ways of accomplishing their work processes in creative, novel, and improvised ways....)</i>	ERP, product lifestyle management (PLM) systems	Longitudinal field survey (6 months) <i>Sample: 582 employees from a medium-size enterprise</i>	<p>lesser effect on adaptation behavior than on conventional IS-use behavior.</p> <p><b>Focus</b> Technology adaptation behaviors to cope with a new IT</p> <p><b>Key findings</b></p> <ul style="list-style-type: none"> <li>Based on whether employees appraised an IT as an opportunity or a threat and whether they had perceptions of control over an IT, the employees performed four different technology adaptation behaviors: exploration-to-innovate, exploitation, exploration-to-revert, and avoidance.</li> </ul>
Sykes and Venkatesh (2017)	Early stage T1: 6 months before implementation T2: 6 months after implementation	Low <i>(Evidence: Much of the challenges of implementing ESs stems from employees' inability to adjust to the new business processes and software, and consequently their new jobs that are part of a new ES implementation)</i>	ERP system	Field survey <i>Sample: 145 product design and development specialists</i>	<p><b>Focus</b> Examine how employee social network ties at work affect deep structure use and job performance.</p> <p><b>Key findings</b></p> <ul style="list-style-type: none"> <li>Both content (i.e., advice and impeding) and source (i.e., friends and acquaintances) of social network ties influence the deep structure use of the new enterprise system and employee job performance.</li> </ul>