Heterogeneity in Technology Adoption of A Novel Early Childhood Teaching Practice[1]

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Very Preliminary

Comments are Welcome

Abstract

This research uses the economic and management theories to examine the heterogeneity in the adoption of an early childhood teaching method, called HighScope. Through data collection of the RIECE Thailand– a research program that has promoted the adoption of HighScope in Maha Sarakham and Kalasin provinces since 2015, this research asks why some teachers adopted wholly while some adopted partially. Both quantitative and qualitative analyses confirmed that a regular year-long interactions between local teachers and RIECE teachers through co-teaching is an effective method for technology transfer leading to high-fidelity adoption while an unstructured week-long on-site training/visit may not be satisfactorily effective. We also found that for high-fidelity adoption to occur it requires co-existence of three mechanisms, including technology transfer, reassurance, and leaders' attention. Teachers' preferences and career attitudes may not lead to effective adoption as

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suggested by current understanding. Our study makes contribution to the adoption of intangible process technology. Unlike the adoption of tangible technology that highlights the importance of adding or subtracting physical elements to encourage adoption, we posit that the adoption of process technology needs to focus on technology transfer, through which adopters truly form essential tacit knowledge of the technology.

1. Introduction

Technology adoption/diffusion is one of the key mechanisms for economic development. Developing countries can catch up with developed countries by adopting new and effective technologies. Therefore, it is very important to understand technology adoption decision of economic agents. Likewise, it is also a central question to the field of management. Management scholars have been intrigued in questions such as how certain technologies or practices come to be adopted widely, while other equally plausible alternatives are not; how a foreign technology, which may misfit with existing routines, is finally accepted and gains legitimacy in a new country; and what accounts for that success. In this paper, economics and management theories are jointly drawn upon to understand decisions of early childhood teachers to adopt a new and effective teaching approach, called HighScope. Specifically in this paper, we were initially inspired with the question: why a technology with well-proved and even longitudinal evidence of its effectiveness such as HighScope was not widely adopted? And why does heterogeneity in the adoption of HighScope occur?

Economists have long been interested in technology adoption decision. Most of the early literature focused on the adoption of agricultural related technologies, e.g., hybrid corn (Griliches, 1957), hybrid maize (Suri, 2011), fertilizer (Duflo, et al., 2011; and Conley and Urdy, 2010). A more recent group of literature studied health related technologies, e.g., deworming drugs (Miguel and Kremer, 2004), bed nets (Cohen and Dupas, 2010), menstrual cup (Oster and Thornton, 2012). Both groups are all about the adoption of tangible products, however. On the other hand, process technologies, e.g., management practices, teaching approaches, can be equally important. But to the best of our knowledge, there is no economic paper dealt with the adoption of an intangible process. One of the main reasons might be the limitation of data and measurement regarding this type of technology and its adoption.

Fortunately, there have been some studies focusing on the adoption of process technologies in management literature. For example, Kennedy and Fiss's (2009) used data on the diffusion of Total Quality Management (TQM) among U.S. hospitals to study effects of motivation (efficiency vs. legitimacy) and issue framing (interpreting the new practice as

opportunities for gains or threats of losses) on adoption of process technology. In their study, they follow Ansari, Fiss, & Zajac's (2010) definition of adoption, as referring to fidelity and extensiveness. Fidelity is the extent to which the implementation of the new practice follows a widely acknowledged template rather than customizing it to the specifics of an organization. Extensiveness is the extent to which the new practice is adopted across organizational or geographical units (Ansari et al., 2010). Their findings reveal that different motivation and issue framing are related to different degrees of technology adoption. With similar interest, Kostova and Roth (2002) drew on the adoption of a quality control practice by subsidiaries of a multination corporation (MNC) to examine factors that affect variation in practice adoption. Yet, they differently conceptualize practice adoption as implementation – "the external and objective behavior and the actions required, or implied, by the practice," and internalization – the state in which adopters view the practice as valuable and become committed to the practice (Kostova & Roth, 2002: 217) under pressure of two forces. The two forces mean that on the one hand they need to conform to their MNC in the home country. On the other hand they confront institutional pressure in the host country. To conduct an empirical test, they operationalize these two forces into relational-context variables and institutional-context variables respectively. They found that the factor that determines the high level of implementation and internalization is an institutional variable – a cognitive institutional profile, which refers to the environment in which people knew a great deal about the practice and many companies adopt it. With regard to relational variables, they found that trust and identification positively relate to the level of implementation. This is in line with Tsai and Ghoshal's (1998) work, which emphasize trust and identification as facilitating exchange of knowledge, reducing ambiguity related to efficiency of the practice, and thus enabling practice adoption.

These existing management studies are important for providing us a starting point and developing our fundamental understanding about adoption of process technology. However, even though these studies shed light on process technology, these technologies such as TQM, ISO, or supply chain management have been long and widely adopted with well-established and clear prescriptions of standards of actions, target measurement, and evaluation. Yet, in the

case of the HighScope, it is a process technology that is ambiguous, equivocal, and still at the primary stage in Thailand. Despite its common and prescribed activities of Plan-Do-Review teaching approaches or classroom design, the effective adoption of HighScope deals with intangibility. It needs teachers' true understanding about its underlying logic and abstract concepts to yield tacit knowledge associated with it. To our knowledge, no studies in the management either have been done in investigating the adoption of ambiguous technology. This is where we contribute to the literature of both economics and management. Understanding such adoption, we believe, is important, as many technologies such as those mostly used in firms such as design thinking, agile methodologies etc., or those used generally in the society such as recycling practices, etc. are process technologies like HighScope, and have so far gained little attention and hence not been implemented effectively.

This research used both qualitative and quantitative data from the Reducing Inequality through Early Childhood Education in Thailand (RIECE Thailand) – a research program that has enacted and promoted the adoption of HighScope. The program has since 2015 engaged in implementing and promoting HighScope at preschools under the management of Subdistrict Administrative Organizations (SAOs) in Maha Sarakham and Kalasin provinces. Over two years, it has been observed that some teachers accepted the new technology, and adopted fully with satisfactory outcomes in children skills, which can be conceptualized as high-fidelity adoption (Ansari et al, 2010). Yet, some are indifferent towards or refused the new technology, and adopted only partially. In the theory of management, such partial adoption is referred to as low-fidelity adoption (Ansari et al., 2010), or ceremonial adoption (Meyer & Rowan, 1997) –adoption occurs only partially or superficially while nothing change at the operational level.

In conclusion, this paper draws on both the economics and the management perspectives, and is approached with both quantitative and qualitative methods in order to understand the heterogeneity in technology adoption, which ultimately enables the researchers to answer what factors influence high-fidelity adoption.

The remainder of the paper proceeds as follows. Section 2 starts with describing qualitative methods, and discusses the qualitative findings of mechanisms that lead to high-

fidelity adoption. In Section 3, a simple economic model, the empirical specification and empirical findings are presented. Section 4 contains the discussion and future research. The interview protocol and specific questions regarding career attitude – attitudes towards being an early childhood teacher – are shown in Appendix A and B, respectively.

2. Qualitative Analysis

This section presents qualitative data collection and analysis, and discusses the primary qualitative findings.

2.1 Qualitative Data collection

Data have been collected between 2015 and 2017 from three sources: (1) semi-structured interviews, (2) nonparticipant observation, and (3) written and electronic documentation and archives. The primary source was semi-structured interviews, while the observation and documentation data served as triangulation and complementary sources for understanding the context of early childhood and SAOs' preschools, and for solving discrepancies among interviews. The second author conducted in-depth interviews with interviewees that were considered as related to the issue of adoption of the HighScope. In total, there were 61 interviews, all recorded upon the interviewees' consent and transcribed verbatim. Each interview lasted from 20 minutes to one hour. Table 1 shows the details of the interviews. The interview protocol (see Appendix A) contained the list of questions, which were used across interviewees pertained to their response and perception towards the HighScope; their approaches to implementing the HighScope in practice, their thought about early childhood education and development in general, their thought about preschools and teaching practices in their local areas in particular, their functional units and organizations, and formal and informal indicators of evaluation of teaching performance and learning outcomes. The interview protocol was customized for hierarchical level, organizational tenure, and geographical units.

Table 1: Interview data

Interviewees	Interview	
	Number	Duration (min)
SAO chief executives	9	236.83
SAO education officers	5	123.64
Local teachers	37	683.72
RIECE teachers	8	192.87
RIECE team members	2	65.64
Total	61	1302.7

The second source is observation. As part of the RIECE team, the second author has engaged in non-participant observation at both sites of preschools and RIECE office, and took detailed field notes during her observation. At the site of preschools, her observation focused on teachers' routines and interaction with kids and among peers. At the site of RIECE, her focal observation was on the team's translation of the HighScope into the Thai version. Translation is a notion of the management theory (see Boxenbaum, 2006; Czarniawska & Joerges, 1996; Sahlin-Andersson, 1996; Zilber, 2006). It focuses on the use of artefact, symbolic, and meaning by agents to explain how a foreign idea, concept, or technologies gains acceptance, and become widely adopted in a new country. Some scholars replaced the concept of diffusion with the concept of translation to understand in-depth the adoption and spread phenomenon (Maguire & Hardy, 2009; Zilber, 2006). In addition, the co-author observed the team's collective interpretation of early childhood development, and their thought about existing teaching activities, outcomes, as well as other alternative practices. The objective of the observation and field notes were to gain in-depth contextual understanding, aid in and enhance the researcher's interpretation, and extract insightful information that may not be explicit or difficult to gain from the formal interviews.

The last source is RIECE's paper and electronic documentations and archives (e.g. presentation slides, brochures, meeting minutes, press release, videos recording daily routines of teaching in class), as well as public data such as news, media, and books regarding early childhood education in Thailand in general, and the HighScope in Thailand in particular.

2.2 Qualitative Data analysis

The data analysis consisted of three stages. First, the co-author drew on accounts of all data collected to build an event history database (Garud & Rappa, 1994), and compose a narrative story. This narrative allowed her to develop understanding of the field, and also used as a temporal track to understand what happened to adopters (teachers) and their stakeholders (e.g., SAO officers, parents, other schools) during the adoption, what effects from the RIECE's actions (such as sending RIECE teachers to co-teach, providing training and workshops for teachers, promoting adoption with provision of children's books) can be on adopters and their implementation. The case description was often crosschecked by the RIECE's staff who engaged on the regular basis with teachers and SAOs.

In the second stage, the second author re-examined the data, focusing on patterns across interviews as well as consistencies and inconsistencies across interviews with SAOs and preschools. Employing the qualitative coding (Strauss & Corbin, 1990; Van Maanen, 1983) as analytical techniques, she identified initial concepts by using language from the interviewees whenever possible, and grouped them into first-order categories.

Then we looked into RIECE's evaluation documents. During the 2-year data collection, the RIECE team followed each preschool's implementation of the HighScope practice, and evaluated their performance. Checking with the literature, the co-author considered that that their RIECE's evaluation criteria can be conceptualized as fidelity. Their criteria basically include whether a preschool implemented the practices and activities proposed by RIECE (i.e., following Plan-Do-Review, designing classrooms into corners, use of RIECE materials developed for different age groups for 2-3 and 4-5 years old, and promoting children's book borrowing), whether they do these practices every day, and what outcomes one can observe from children's development. Then the RIECE team scored and ranked each school accordingly. Building on this ranking, the second author after consulting with the RIECE team grouped the scores into categories and labeled each category with 'excellent', 'very good', 'good', 'fair', 'poor', and 'very poor'. Although she did not interview all the preschools, she based on these categories and interviewed representatives of each category through

recommendations of the RIECE team. Checking with the literature, she defined that excellent and very good adopters fit with the definition of adoption with high fidelity, while those ranked as fair, poor, and very poor fit with the definition of adoption with low fidelity. Then she focused her examination on these two new categories. This focus of data from different adopter categories allowed her to examine how adopters with high fidelity and those with low fidelity responded to the HighScope, how they perceived, and how they implemented the HighScope, as well as what were obstacles or issues for them in implementing the HighScope.

In the third stage, she used axial coding – the search for and identification of relationship among first-order categories (Strauss & Corbin, 1990). At this stage, the question that she had in mind in guiding the coding system is what factors affect difference in technology adoption, and what factors influence adoption with high fidelity. At this stage, she focused on patterns, similarities across first-order categories and relation among these categories, then collapsing first-order categories into a smaller number of second-order themes or axial coding. This was not a linear process, but proceeded iteratively among data, emerging themes, and literature to find refined conceptual themes or aggregate-theoretical dimensions. Then during these second-order themes, it became clear that these themes are associated with particular causes and outcomes: *low-fidelity adoption* associated with attitudes towards change that can be conceptualized as *organizational resistance* and the lack of resources; and *high-fidelity adoption* associated with 4 themes, including *reassurance*, *outcome realization*, *technology transfer*, and *leaders' attention*. Figure 1 shows analytical process that contains coding from first-order categories, second-order themes, to aggregate dimensions for ceremonial adopters and non-adopters. Figure 2 shows analytical process for high-fidelity adopters. Table 2 and 3 show representative interview data as evidence to support Figure 1 and 2 respectively.

2.3 Trustworthiness of the data

Interview data has limitation. It is limited to interviewees' experience, understanding and interpretation, and ability of a person to articulate, while also limited to what interviewees think as relevant and are willing to share with researchers. To compensate these limitations, the second author conducted interviews with a wide range of interviewees as many as possible, at

different hierarchical level, from various functional units, and in different geographical areas. Also, to minimize the risk of idiosyncratic data, she hence collected multiple data sources that included observation and documentation published both internally and externally. Many management scholars support the use of observation techniques in data collection. It is acknowledged that, in addition to the limitations of interview techniques mentioned above, some insights are intrinsic in the context, which needs researchers' interpretation to extract them out Many concepts of management such as sense-making and identity have been benefited from the observation technique. Hence, observation plays a potent role in this paper.

Another concern that may be raised regarding qualitative analysis is the coding system. To ensure the trustworthiness, the second author showed her primary coding and findings with researchers of the RIECE team, to gauge whether her interpretation and coding makes sense and true to the case. In the future, she will follow other qualitative researchers by involving another qualitative researcher to conduct the coding and compare with hers, as well as presenting the findings to some interviewees, RIECE team members, and researchers from the same and different disciplines to triangulate and ensure internal validity of the findings.

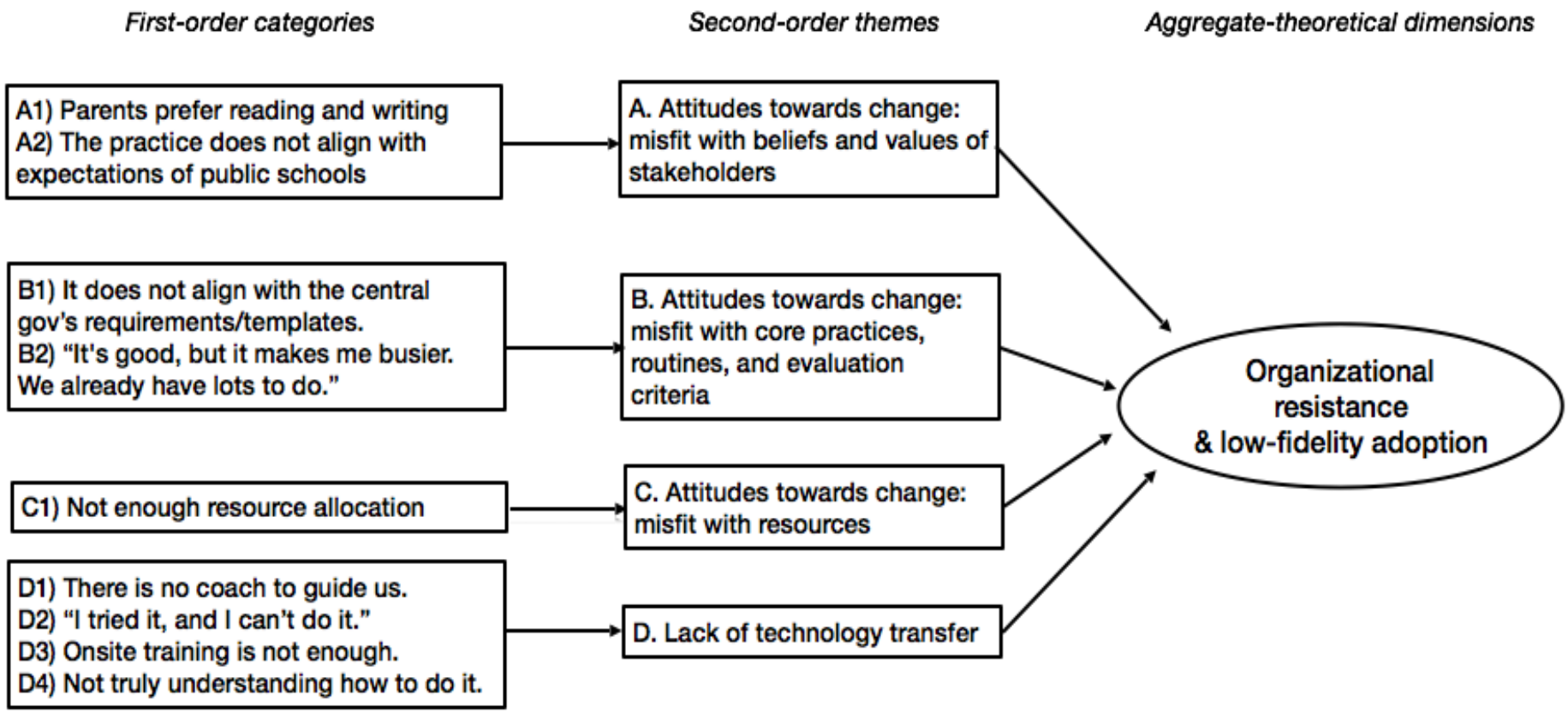

Figure 1: Analytical process for ceremonial adopters and non-adopters.

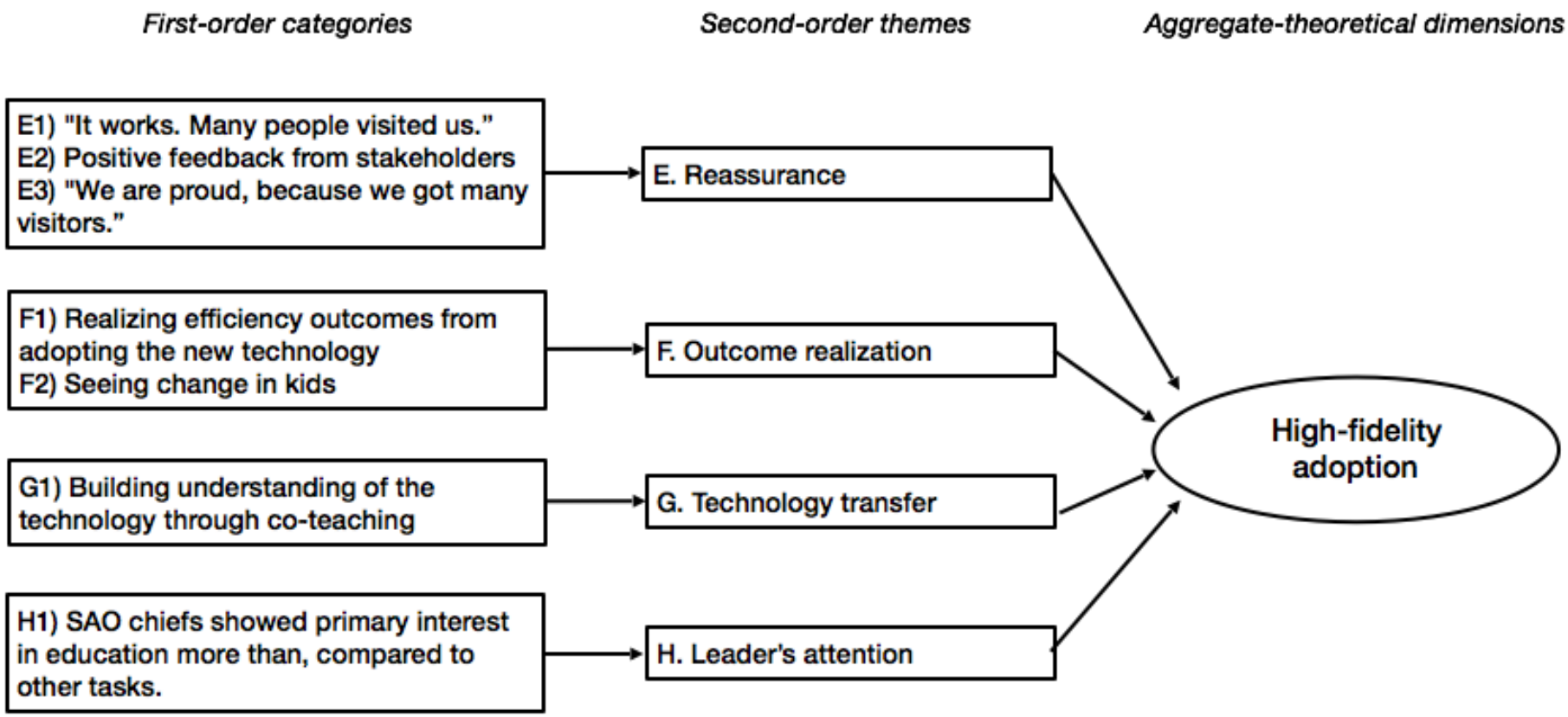

Figure 2: Analytical process for high-fidelity adopters

Table 2: Dimensions, themes, categories, and data for coding of low-fidelity adoption

Second-order themes & first-order categories		Representative data
Aggregate dimension: Organizational resistance & low-fidelity adoption		
A. Attitudes towards change: misfit with beliefs and expectations of stakeholders	A1)	Parents prefer reading and writing. "ไฮสโคปนี้ก็เข้าสู่บทเรียนตามหน่วย แต่ผู้ปกครองอยากให้เด็กได้เรียนหนังสือ ผู้ปกครองบางคนเขาบอกว่ามาโรงเรียนไม่ได้หนังสือ ก็เราจะทำยังไงล่ะ อยากให้ลูกจำได้อยากให้ลูกเขียนได้แต่วัยของเด็กมันยังไม่ถึง" (interview, local teacher).
	A2)	The practice does not align with expectations of public schools. "ผมห่วงเรื่องการส่งต่อว่าเราทำตรงนี้เนี่ยคือให้เด็กกล้าคิด กล้าทำ กล้าแสดงออก มีความเชื่อมั่น พอเราส่งต่อไประดับป.1 ที่โรงเรียน ครูตรงนั้นแหละไม่เข้าใจ ผมคิดนะผมกังวล ว่าเขาจะบอกจบจากศูนย์เด็กเรา ทำไมเรียนหนังสือก็อ่าน หนังสือไม่ออก ยังท่อง abc ไม่ได้" (interview, SAO).
B. Attitudes towards change: misfit with core practices, routines, and evaluation criteria	B1)	It does not align with the central gov's requirements/templates. "[ครูที่ศูนย์] ไม่เอาเลย เขาบอกว่าใช้ไป อบต.ก็ไม่ตรวจ เขาก็ตรวจของกรม อบต.ก็มีเอกสารที่เขาอยากเห็นอยู่แล้ว" (interview, a local teacher).
	B2)	"It's good, but it makes me busier. We already have lots to do." "เป็นกิจกรรมที่ดีค่ะเด็กก็เรียนรู้ แต่ก็ไม่ค่อยได้ทำ Plan Do Review ทุกวันค่ะ เพราะว่าบางวัน พี่ก็ไม่ใช่แต่สอนเด็กพวกนี้ พี่ต้องมาทำเอกสารอะไรอีก พวกพัสดุอะไรอย่างนี้ ก็เลยเป็นอะไรที่วุ่นวาย HighScopeเนี้ยมันต้องทำให้เรา ทำงานเพิ่มขึ้น มันก็เป็นกิจกรรมที่ดี แต่ว่าเราก็มีงานเยอะอยู่แล้ว" (interview, local teacher).
C. Attitudes towards change: misfit with resources	C1)	Not enough resource allocation "ทีนี้ถ้าสมมติว่าเรามีของ เรามีกิจกรรม มีอะไรเนี้ย พี่ไม่มีตังค์ซื้อเนาะ ที่แน่ๆ มันจะมีพวกอุปกรณ์อะไรเยอะแยะเนาะ มันก็ดี พี่เคยไปดูงานบ้านหนองตอกแป้น เพื่อนพี่ก็อยู่นั่น พี่ก็ว่ามันดี แต่ว่าเราจะมาทำเหมือนเขาพี่ก็ไม่มีตังค์ซื้อ" (interview, local teacher).
D. Lack of technology transfer	D1)	There is no coach to guide us. อบต.เขาให้เราทำนะก็ทำไปเรื่อยๆ แต่ว่าเหมือนกับว่าเราเหมือนกับไม่มีคนพาทำ เพราะว่าที่นี่ไม่มีคุณครูมานะ ไม่เหมือนกับที่อื่น อย่างหนองตอกแป้นเขามีคุณครูมาช่วย ใช่ไหมค่ะ เขาก็ต้องไปได้ใช่ไหม (interview, local teacher).
	D2)	"I tried it, and I can't do it." [ที่ศูนย์ที่ไม่มีครูโครงการ RIECE ร่วมสอน] "มันก็ดีนะคะโครงการของเขา แต่ว่าเรายังไม่เข้าใจลึก ๆ อ่ะ ก็อยากจะทำตามนะคะ แต่ว่ามันยังไงไม่รู้ แนวทางปฏิบัติเรายังไม่เข้าใจอะไรมากมาย ก็เลยจับไต๋ไม่ได้ แต่ก็ดีนะคะถ้าเราทำได้ เห็นหนองตอกแป้นว่าดี" (interview, local teacher).
	D3)	Onsite training is not enough. "เราไปอบรม แต่ก็เป็นแบบอธิบาย มาดูหนองตอกแป้น เราก็ยังไม่รู้ ไม่เข้าใจอยู่ดี ว่าปฏิบัติแล้วจะยังไงต่อใช่ไหมคะ" (interview, local teacher).
	D4)	Not truly understanding how to do it. "[นักวิจัยถาม: ทำไมคุณครูของศูนย์บางศูนย์เนี้ยเขาถึงไม่อยากใช้ไฮสโคป] เขาไม่เข้าใจจริงๆถ้าเขาศึกษาหลักสูตรจริงๆเขาจะเข้าใจ แต่ตอนนี้คือไปคุยๆกันเขา เขาพูดเป็นภาษาบ้านเราแบบว่ามีแต่อันเก่าซ้ำซากซ้ำซากนะ [เท่าที่นักวิจัยสอบถาม ผู้สัมภาษณ์หมายถึง Plan Do Review ที่ต้องทำทุกวัน] ซึ่งจริงๆแล้วเขาไม่เข้าใจ (interview, local teacher).

Table 3: Dimensions, themes, categories, and data for coding of high-fidelity adoption

Second-order themes & first-order categories		Representative data
Aggregate dimension: High-fidelity adoption		
E. Reassurance	E1)	"It works. Many people visited us." “ตอนน้องครูโครงการเข้ามาตอนแรกเนี้ย เขาจะทำห้องเดียวก่อนนะคะ ก็ผลปรากฏว่า มันได้ผลค่ะ ก็มีอาจารย์มาเอาพวกนักศึกษาจาก มมส. มาดูงาน โรงเรียนสาธิตค่ะ มาดูงาน” (interview, local teacher).
	E2)	Positive feedback from stakeholders ผู้ปกครองก็ดีคือผู้ปกครองมีผลตอบรับมาคือ 1.คือโครงการพานิทานกลับบ้าน เพราะว่าเด็กได้นิทานกลับไปคือเด็กจะรู้นิทานทุกเรื่องเลย (interview, local teacher).
	E3)	"We are proud, because we got many visitors.” ภูมิใจว่าเออศูนย์เรามันดีขนาดนั้นเหรอที่มีคนมาดูเรา ถึงขนาดโรงเรียนของ สพฐ.ก็มาเงี้ย มันดีถึงขนาดนั้นอย่างเงี้ยก็ภูมิใจอยู่ (interview, local teacher).
F. Outcome realization	F1)	Realizing efficiency outcomes from adopting the new technology “ภาระงานในส่วนที่เราต้องเป็นกิจกรรมประจำวัน อย่างสร้างงานเขียนคือ หนังสือนิทานยืมกลับบ้านเราก็ทำทุกวัน จากแต่ก่อนไม่เคยทำ นี้คืองานที่เพิ่มเข้ามา แต่ก็ลดส่วนหนึ่งคือความมีวินัยของเด็ก จากแต่ก่อนที่เด็กเข้าเล่นตามมุมเค้าเล่น แล้วไม่รู้จักเก็บ มันก็เหนื่อยเราที่เป็นคนเก็บซึ่งก็หนักในส่วนนี้ แต่พอมาเป็นไฮสโคป เด็กมีวินัยขึ้น ภาระงานของคุณครูก็เบาลง” (interview, local teacher).
	F2)	Seeing change in kids “พอเด็กได้เริ่มเรียนก็เริ่มมีวินัยมีระเบียบขึ้นทำให้ครูมีกำลังใจที่อยากจะทำต่อ” (interview, local teacher). “แต่มาเรียนรู้กับ ไฮสโคป แล้วรู้สึกว่าเด็กเขาหนิ มีมารยาทเยอะขึ้นเลย และเด็กมีระเบียบด้วย [นักวิจัยถาม: แล้วเรื่องสมองและพัฒนาการล่ะคะ] เรื่องสมองพัฒนาดีมากเลยค่ะ [นักวิจัยถาม: เราสังเกตจากอะไรคะ] สังเกตจากที่เด็กเขาพูด การกระทำ แม้กระทั่งที่เขาไปอยู่บ้านเขาไปดู คุณพ่อคุณแม่ทำกับข้าวอยู่ที่บ้าน น้องก็สังเกตว่าเมื่อวานที่บ้านเขาทำยังงี้ วันนี้น้องเข้ามุมบ้านอีก แล้วทำแบบแปลกใหม่เข้ามาอีก” (interview, local teacher).
G. Technology transfer	G1)	Building understanding of the technology through co-teaching “ตอนแรกก็ยังไม่เข้าใจอะไร คือเราเข้าไปอบรมเราไปฟังคือเราไม่เต็มร้อย … เราก็ไปฟังฟังทีนี้ฟังที่อาจารย์ตอนแรกอาจารย์ xx มาคุยตอนนั้นก็ ก็ยังไม่เข้าใจยังไงเท่าไหร่ ทีนี้พอได้ครูโครงการ RIECE มา เราทำไม่ได้เราจะทำยังไงดีล่ะทีนี้ คือเราก็อ่ะทำ เขาพาทำเราก็ต้องทำซิ” (interview, local teacher). [นักวิจัยถาม: ตอนนั้นที่ทำให้เราเข้าใจ [HighScope] เนี้ยจริงๆแล้วเป็นเพราะอะไรคะ] “เพราะเห็นวิธีการที่น้อง[ครูโครงการ]เขาสอน”(interview, local teacher).
H. Leader’s attention	H1)	SAO chiefs showed primary interest in education, compared to other tasks. “ผมสนใจเรื่องการศึกษานะครับ ผมคิดว่าการศึกษามันเป็นเรื่องสำคัญ ถ้าจะดูในศูนย์ผมเนี่ยผมทุ่มงบประมาณลงมา ผมตั้งศูนย์ตั้งแต่ปี 49 เริ่มทุ่มงบลงเรื่องศูนย์และอาคารเรื่องอะไรเนี่ยต่างๆเนี้ย ผมคิดว่าผมเล่นเรื่องนี้ มากพอสมควรนะ” (interview, SAO). “เบื้องต้นสำหรับ ในการศึกษานะครับผม มองว่านี้ว่า ขึ้นอยู่กับตัวหัวก่อนก็คือ ผู้บริหารท้องถิ่นคนนั้นก่อนว่า เขาพร้อมที่จะเปิดโอกาสพร้อมที่จะรับโครงการ ใหม่ๆเข้ามาในพื้นที่ตัวเองนี้หรือไม่นะครับ (interview, SAO).

2.4 Qualitative Study's Findings

Organizational resistance as source of low-fidelity adoption

Through the primary analysis, dimensions and themes that could explain different level of technology adoption emerged. The co-author found organizational resistant as a dimension attributed to low-fidelity adoption. Organizational resistance occurred due to adopters' attitudes towards change and the new technology as misfit with existing beliefs and values of stakeholders such as parents and public schools; misfit with current practices, routines, and evaluation; and misfit with existing systems of resource allocation. This corresponds with organizational culture theory in the management field, explaining that practices that clash with existing norms, beliefs, and routines tend to encounter resistance from adopters. This is not surprising and true to many cases of change at the early stage. In the interviews, many teachers with low-fidelity adoption expressed their concerns about the adoption because their workloads were already tight. They were also afraid that parents might not like this new technology, since it does not highlight reading and writing. In the long run this might be the reason why local parents would not send their kids to their schools. Interestingly, these concerns on workloads and stakeholders' expectations were not found among teachers with high-fidelity adoption. In contrast, high-fidelity teachers stated that they received positive feedback from many parents about their kids' behavior at home and parents' praise about the activity of children's book borrowing. Scholars explain that new technologies that contradict with established routines, norms, and resource allocation systems will create emotional discomfort (Bartunek, 1984; Schein, 1985), leading to reluctance and resistance to implement the new technology. To promote the adoption, it needs change in attitudes. Yet, such change takes time, since attitudes are rooted in belief that current practices are also good and effective in the eyes of adopters and stakeholders (i.e. we do what we think it is good. That is why we still have kids coming to study with us. Parents like the way we teach); and taken-for-granted and routinized behavior that has over time been influenced and maintained by power structure and incentives (i.e. we need to follow orders from the SAOs. They are the ones who give us salary.).

For adoption to occur, we can turn to the diffusion literature, which explains that early adopters are motivated by a desire to yield economic and functional gains (Tolbert & Zucker, 1994). When the adoption has success stories, the new technology becomes compelling and easier to adopt, encouraging more adoption. As the quantities of adoption increase, the new technology gains more or less social agreement regarding its pragmatic value, and becomes considered as appropriate and necessary. Imitation of adoptions is accelerated. Late adopters follow suit, with a desire to appear legitimate more than to gain pragmatic values as early adopters (DiMaggio & Powell, 1983; Greenwood, Oliver, Suddaby, & Sahlin-Andersson, 2008; Meyer & Rowan, 1996; Suchman, 1995). The point for practical suggestions is that, in order to overcome resistance and promote adoption, creation of exemplary schools that can adopt HighScope effectively is needed. Also, to accelerate the diffusion, social awareness of its effectiveness is required.

Another theme that leads to the low-fidelity adoption is the lack of technology transfer. In contrast to attitudes towards change that result in organizational resistance, the lack of technology transfer is more controllable. Many teachers at low-fidelity adoption stated in the consensus that they did not truly understand how to implement HighScope. They tried it but still could not do it well. One reason is that they did not have a co-teachers to guide them. It may be that when they were giving training onsite, they understood the broad picture. Yet, upon implementation themselves, they faced challenges and questions that they did not know how to cope with, thereby becoming resisting the adoption. This emphasizes that adoption of process technology, unlike tangible technology, needs approaches to promote formation of tacit knowledge. Through comparison with high-fidelity teachers, these teachers have RIECE teachers to co-teach. This technology transfer will be explained further in the next sub-section.

Mechanisms leading to high-fidelity adoption

This sub-section provides descriptions of findings on mechanisms leading to high-fidelity adoption of process technology. Figure 3 illustrates the findings. To achieve adoption with high fidelity, the analysis revealed four themes: reassurance, technology transfer, leader's attention, and outcome realization. The first three dimensions that appear in rectangular boxes

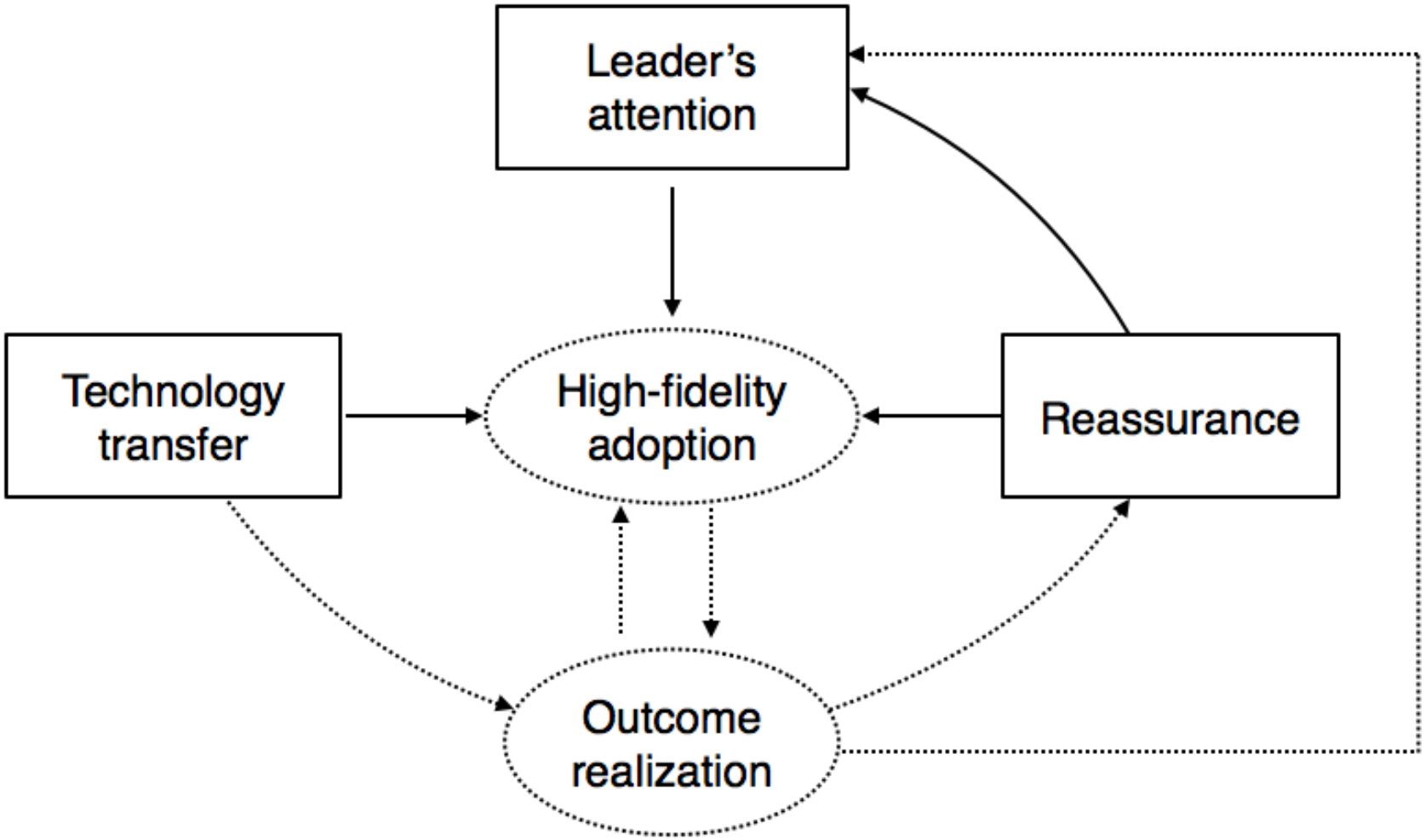

Figure 3: Mechanisms leading to high-fidelity adoption of process technology

and straight lines indicate controllable dimensions, while the last dimension that appear in dotted oval and dashed lines refer to uncontrollable dimension.

The relationship between technology transfer and high-fidelity adoption may be explained by two aspects. First, technology such as HighScope is new and foreign. For local teachers to adopt, it requires 'translation of the technology' to be pragmatic and appropriate (Czarniawska & Joerges, 1996; Sahlin-Andersson, 1996). The new technology is considered pragmatic, when it is easy, convenient, and effective for adopters. And it is viewed appropriate when it aligns with the institutional context (Greenwood & Suddaby, 2002; Suchman, 1995). To make HighScope pragmatic, RIECE engaged in translation of HighScope into the Thai version. RIECE has worked to align the new technology with pragmatic value e.g., creating informative and easy-to-understand teaching materials for implementing HighScope, providing RIECE teachers to co-teach, providing trainings for beginning adopters, and giving feedback and supervision. Also, RIECE rendered HighScope appropriate especially in the eyes of high-fidelity teachers, by aligning the technology with the institutional context i.e., the teaching material designed by RIECE are the same as and corresponds with the template and the main idea of the central government that SAOs need to follow. Interestingly, some teachers with low-fidelity adoption thought otherwise that HighScope and RIECE's materials are different from the central government's requirements. For example, one comment is that they are different in terms of daily teaching routines or forms of documents teachers use to report on teaching outcomes to SAOs, even though there are no detailed prescriptions of daily teaching practices or any central forms from the central government. To ensure collective understanding that HighScope and RIECE's materials do not conflict with the central requirements, it needs more translation of HighScope to fit local way of understanding even more. Nevertheless, the overall analysis shows that technology transfer lead to high-fidelity adoption. Yet, methods for transferring technology and translation are also important.

The second part of technology transfer affects high-fidelity adoption through outcome realization. The qualitative analysis showed that teachers "made sense" (Weick, 1979) or may form tacit knowledge through interaction with RIECE teachers. This may be explained by using

the concept of sense-making – the cognition-action processes of environmental observation, interpretation, and action (Gioia & Chittepeddi, 1991; Weick, 1979). It may be that formation of tacit knowledge occurs during this sense-making process together with feedback loops through interaction between local and RIECE teachers. Also, during this technology transfer, local teachers realized change outcomes (i.e. more self-confident, disciplined, and lively) in children, under care of RIECE teachers and from implementing by themselves. This outcome realization thus result in high-fidelity adoption. High-fidelity adoption then results back in outcome realization, and vice versa.

Furthermore, when the co-author investigated deeper why these teachers adopted with high-fidelity consistently and continuously, the data revealed another two themes – reassurance and leader's attention – occur concurrently. Some teachers at the preschool with the highest level of fidelity stated that they tried to learn from RIECE teachers (technology transfer) and they saw change in kids (outcome realization). Yet, they became more certain that HighScope worked when external parties visited them. They were proud of themselves, which in turn increase the likelihood of high-fidelity adoption. Leaders' attention also emerged as another theme that encouraged high-fidelity adoption. In the interview data, leaders who put weight to education as one of the top priorities, are the ones whose preschools show high level of fidelity in adoption. It is not ascertained from the data that leader's attention or outcome realization comes first. Yet, it is arguable that leaders' attention directs teachers' actions, and through this, teachers who perform well gain recognition from leaders. This dynamic of leaders and teachers hence may lead to high-fidelity adoption.

The requisite of the three mechanisms of technology transfer, reassurance, and leader's attention are confirmed when the co-author compared the data between teachers with high- and low-fidelity adoption. Interestingly, she found that all the three exist during the implementation of the former, while either leader's attention or reassurance, or both, are missing in the latter's implementation. Based on this present analysis, it may be concluded that technology transfer, reassurance, and leader's attention are important for high-fidelity adoption.

3. Quantitative Analysis: Factors Determining HighScope Adoption by Early Childhood Teachers

This section presents an empirical analysis regarding an adoption of new teaching method, the HighScope approach (e.g., Schweihart and et al. 2005; Heckman and et al., 2010), by early childhood teachers in rural Northeastern Thailand. Most of the results in this section should not be interpreted as causal effects. We would need more careful and further investigations to understand their causal relationships.

3.1 Conceptual framework for teaching technology adoption

This section proposes a simple model to guide our analysis below. There are two main parts; skill formation process and teachers' preferences. The skill formation process depends on the teaching method. More formally, the traditional teaching method is represented by a production function $f(e, A, m)$, where A is the productivity of the teacher and m is the classroom environment. Similarly, the skill formation process of the HighScope approach is represented by $h(e, A, m)$. Both production functions are assumed to be increasing in the effort, productivity, and classroom environment. The sources of heterogeneity in production processes are productivity and classroom environment. With limited data on classroom environment, we will focus mainly on the productivity part in this paper.

The difference between the two approaches is illustrated in Figure 4 below. We assume that when the effort level is low, the traditional approach (e.g., direct instruction) can lead to a higher skill. On the other hand, the HighScope method will lead to a superior outcome when the effort is sufficiently high. This structure of the production function with respect to teachers' effort is to capture the fact that teachers have to positively and intensively interact with children in order to effectively implement an active learning approach like HighScope. Surely, such intensive interaction requires more teacher effort, which is costly for teachers.

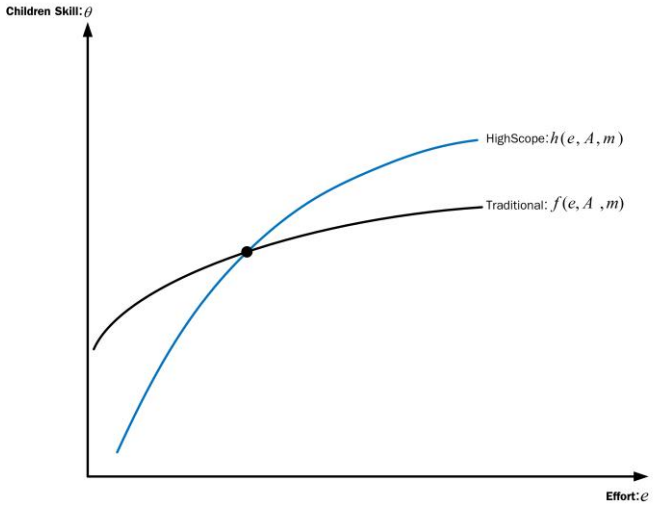

Figure 4: Production frontiers for the traditional method (black line) and the HighScope method (blue line).

The utility function can also be heterogeneous across teachers. For simplicity, a teacher's preferences can be represented by a utility function $U(e, \theta, B)$, where e is teacher effort, θ is the children skill, and B represents other factors affecting preferences including attitude toward being an early childhood teacher, job security, teachers' indebtedness, bonus system. For example, a teacher with the better attitude would assign more weight toward children skill and therefore lead to a flatter indifference curve, as shown in Figure 5. The utility function is assumed to be decreasing in the effort e and increasing in the children skill θ.

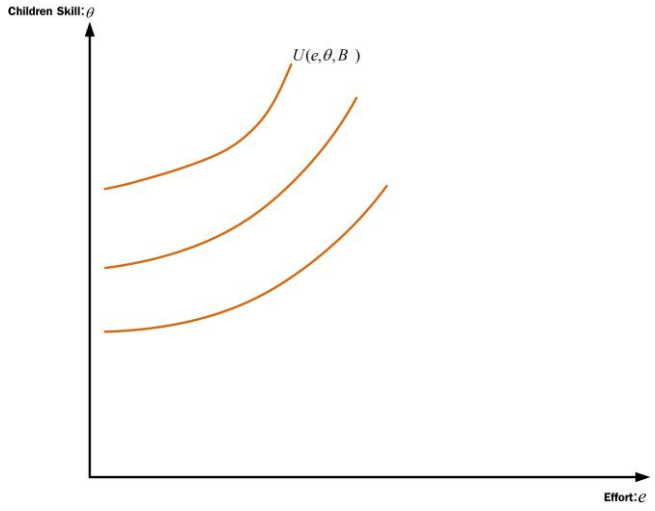

Figure 5 Indifference curve for a teacher. The uitlity is increasing along the north-west direction.

Each teacher chooses her effort and teaching method to maximize her own utility taking classroom environment and other factors as given:

$$\max_{f \text{ or } h}\{\max_{e} U(e, f(e, A, m), B), \max_{e} U(e, h(e, A, m), B)\}$$

Graphically, the optimal choice of a teacher is where her indifference curve tangent with the production frontier as shown in Figure 6. In this case, the teacher chooses the traditional method and obviously, it gives her the highest utility. With technology transfers through co-teaching with RIECE teachers, the productivity for the HighScope then increases from A to A'. Graphically, the production frontier will shift upward. This hike in productivity could, in turn, lead to more adoption, as shown in Figure 7. Similarly, teachers with a different attitude toward being an early childhood teacher could end up choosing different teaching methods as shown in Figure 8. The teacher with the better attitude, who has a steeper indifference curve, could then choose the HighScope with higher effort. Another interesting case is the attention of the SAO leader. This factor can impact the adoption through both production and preferences. For the production side, more attention from the leader should lead to more resources which in turn can help improve the quality of the classroom environment. This improvement then should shift the production frontier upward. Likewise, the improved attention should also bring in more monitoring or oversight from the SAO. More monitoring then should drive the teachers to care for children skill more than otherwise. That would lead to a steeper indifference curve. Both production and preferences channels for the leader attention clearly lead to more adoption in this case. See Figure 9. These three cases have illustrated how we can apply our simple conceptual framework/model to explain how each factor of interest could affect a teacher's adoption decision. The differences in those key factors then generate heterogeneity in the adoption.

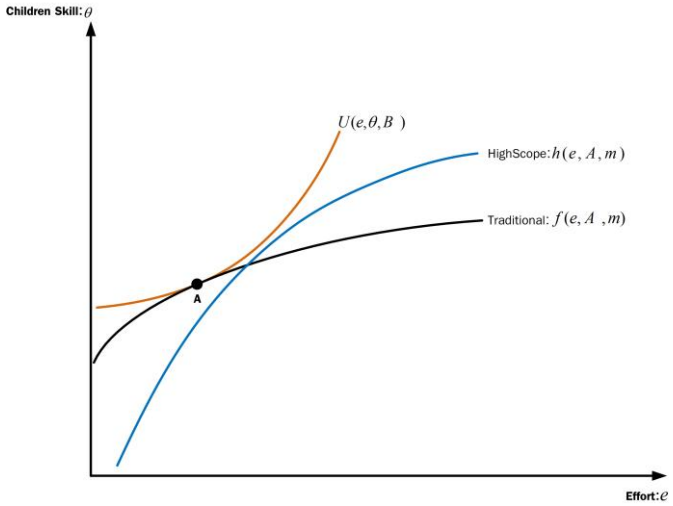

Figure 6: The indifference curve is tangent with a production frontier at the optimal choice of the teacher. The teacher chooses the traditional approach in this example.

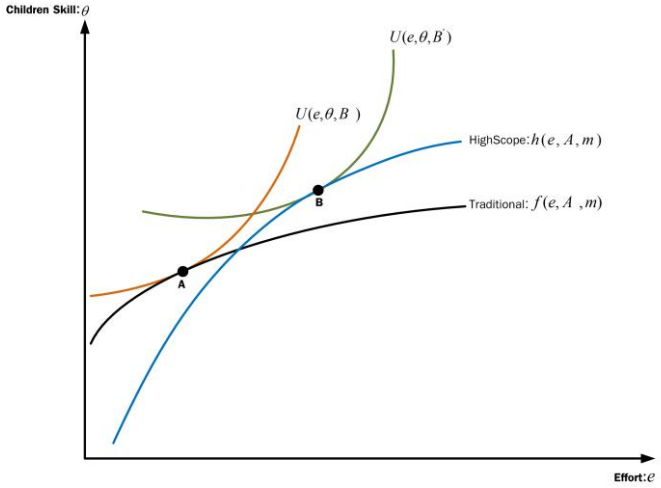

Figure 7: The teacher with the better attitude with $B' \neq B$, who has a flatter indifference curve, chooses the HighScope and exerts higher effort.

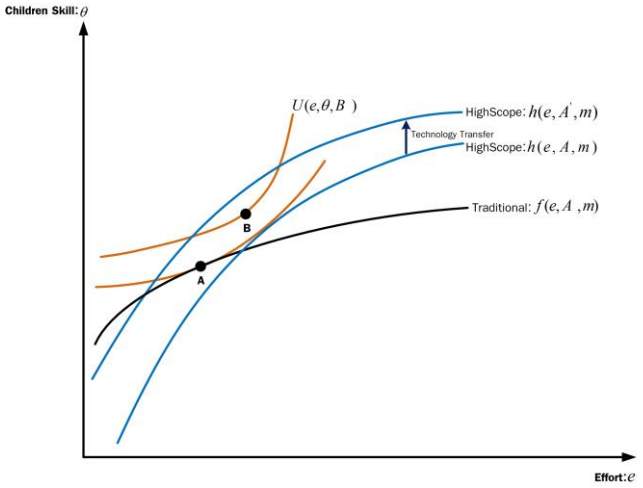

Figure 8: An increase in teacher productivity from A to A' boosts the likelihood to adopt the HighScope because it shifts the production frontier of the HighScope upward.

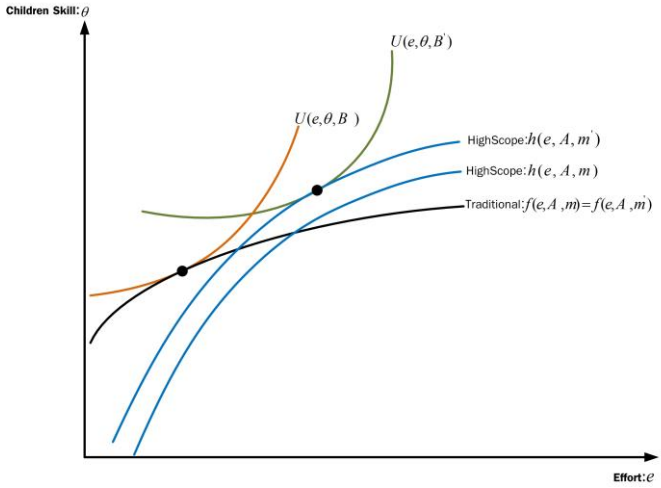

Figure 9: More leader attention leads to better classroom environment with $m' > m$ *(an upward shift of the production frontier) and higher utility toward children skill (flatter indifference curve), both of which in turn increase the likelihood to adopt the HighScope.*

3.2 Teacher adoption measurement

We measure two types of adoption, ceremonial and high-fidelity adoptions, based on the qualitative concept discussed in Section 2. In particular, the ceremonial adoption is constructed from our questionnaire asking each teacher whether they implemented the plan-do-review in her classroom. On the other hand, the high-fidelity adoption is more complicated. It is constructed using the judgment of our two academic personnel who visited each center regularly. We then asked them to evaluate the quality of each teacher based not only on the quality of the plan-do-review process but also the other key activities, e.g., small group, large group, book borrowing etc. In particular, their answers were recorded as a grade (A, B, C, D, F) for each of the teacher. We then assigned the equivalent score for each grade, i.e., A=4, B=3, C=2, D=1 and F=0. We then use the average score from both persons to represent the teaching quality. If we received only one evaluation, we then use that number. It is worthy of emphasis that this measurement is quite arbitrary and should be interpreted with cautions. Nevertheless, we believe that we can learn from it.

3.3 Empirical specification

Our estimations are based on the following linear specification

$$y_i = \alpha + \boldsymbol{\beta} \bullet \mathbf{X}_i + \varepsilon_i \ , \quad (1)$$

where y_i is the adoption variable (ceremonial adoption and high-fidelity adoption) for teacher i, $\mathbf{X}_i$ is the set of independent variables including age, age squared, student-teacher ratio, Riece-teacher dummy, on-site training, early childhood education degree, bonus availability in 2014, teacher's indebtedness, teacher attitude toward being an early childhood teacher, civic-servicer teacher dummy, teacher's local tie, having co-teacher dummy, belief in the necessity of homework. The Probit model is applied to analyze the ceremonial adoption (claiming that using the PDR only) because the outcome is a binary variable. On the other hand, the high-fidelity adoption (teaching quality) is analyzed using the standard ordinary least square model.

3.4 Empirical Findings

Teacher Training and On-site Training

One way to improve teachers' knowledge is training. In fact, the project held a two-day in-class training for almost all local teachers (247 teachers attended) on 6-7 April 2014. Many of them (156 teachers) also attended a two-day intensive workshop (3 workshops were organized), each of which has about 50 teachers attended. This workshop was supposed to give basic knowledge of how to set up the classroom environment according to the HighScope method.

The first empirical evidence is the fraction of local teachers who claimed that they haveadopted the HighScope during the first academic year. See Figure 10 below. The blue line represents the adoption rate for all local teachers including the RIECE teachers. In order to screen out the direct effect of the RIECE teachers, we focus instead on the red line, which represents the adoption rate of local teachers working in the centers with no RIECE teachers. The adoption looked to be saturated at about 30% after the first five months. It is worthy of noting that each center had been visited regularly by our academic staffs every month since June 2015.

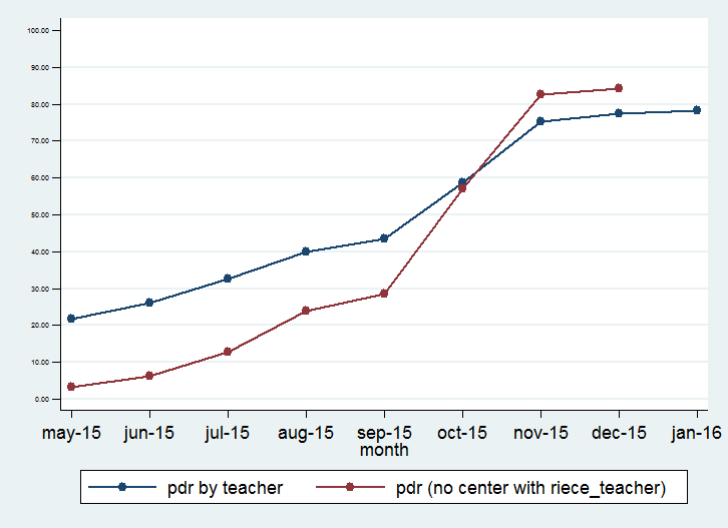

Figure 10: The fraction of local teachers who ceremonially adopted the HighScope (claimed that they have adopted the plan-do-review process in the classroom) at the end of each month in the academic year 2015-2016..

The key point here is that the adoption has then increased sharply after the month of October when a five-days-on-site training/visit was implemented. In particular, the adoption had increased from slightly less than 30% to more than 80% in November. This clearly suggests that the onsite-training/visit had increased the likelihood to ceremonially adopt of the local teachers.

We now turn to a formal statistical analysis. The coefficient of the week-long on-site training variable in Table 4 is positive but not statistically significant. Of course, the insignificance might come from the small size of the data. Alternatively, it might come from the empirical specification itself. Note that the on-site training variable is equal to one if the teacher attended the training and zero otherwise. This measurement could miss out on the spillover effect of the training. That is, it is possible that the trainees might be convinced by what they have seen during the training, and in turn helped convince other teachers in their centers to adopt the HighScope. To test this idea, we redefined the on-site training variable as a dummy capturing whether the center sent any teacher to the training. This variable will be one for a teacher if she was working in a center that sent at least one teacher to attend the training. The results in Table 5 are consistent with the hypothesis. In particular, the estimated coefficients of the new on-site training as a center were positive and statistically significant. In addition, the spillover idea also suggested that the effect might be varied with the size of the center. In particular, the project required that each center could not send more than two trainees.

Empirically, we also created a variable capturing the ratio between the number of trainees and the total teachers in the center, called training ratio. Again, the estimated coefficients of the training ratio were positive and statistically significant. See Table 6. To sum up, we found that teachers who were working in a center participating in the on-site training are more likely to ceremonially adopt the HighScope. What about the quality of the adoption?

Unfortunately, the on-site training did not seem to improve the quality of the adoption. The estimation coefficients of all three types of the on-site training variable in Table 7-9 were not significant in all specifications. This ineffectiveness might come from the fact that we could not control the quality of the training well enough. The training was organized in 14 centers at the same time. With a limited number of academic staffs, most of the trainees were left with the local teachers and our young RIECE teachers, who could implement the HighScope method but may not be able to teach/coach other teachers in a short period of time yet. In addition, the quality may be heterogeneous across the training centers. In fact, at the time of the training, those training centers were clearly better than the rest but still in an early stage. They might have done something right but still needed to improve in many respects.

To sum up, we are quite confident that a week-long on-site training can boost ceremonial adoption significantly. However, the high-fidelity adoption requires more than just being an observer on the site. With these valuable lessons, the project is currently developing and experimenting an on-site training program with an intensive support from our academic personnel and more hands-on teaching experiences. Importantly, in order to ensure that participants will be exposed to a high-quality teaching, there is only one childcare center that can serve as a training center at the moment. We will need to collect more data and evaluate if this new approach can be an important catalyst for the high-fidelity adoption.

Technology Transfers through RIECE Teachers

A key activity of the RIECE project is the RIECE teachers, who were randomly assigned to co-teach in 19 out of 51 childcare centers. The randomization clearly helps mitigate a selection bias. Most of the RIECE teachers were new graduates in early childhood education

from a local university. They were recruited and trained how to teach with the HighScope at our two pilot childcare centers for two weeks right before the beginning of the first semester. To further support and monitor them, they were required to attend a weekly meeting on Saturday for the first few months and then became monthly meeting after that. Conceptually, the presence of an early childhood teacher who was supposed to know how to teach with the HighScope should increase the productivity of the local teachers, as described earlier. Therefore, we should expect to see a positive estimation coefficient of the presence of a RIECE teacher in the center.

Empirically, the estimation results for a ceremonial adoption (claiming to use PDR process) in Table 5-6 imply that having a RIECE teacher co-teach in the center does increase the likelihood to adopt the Highscope significantly. The coefficients of the dummy for the presence of a RIECE teacher at the center were positive and significant. In addition, having a RIECE teacher raises the teaching quality significantly in all specifications. See the fourth row in Table 7-9. These results together imply that technology transfers through regular and intensive interactions between RIECE and local teachers can raise the productivity for the HighScope and therefore increase the likelihood to have the high-fidelity adoption. In other words, having a RIECE teacher in the center helps improve teaching quality significantly because it sufficiently increases the productivity for the HighScope approach.

Holding a Degree in Early Childhood Education

A related issue is that teachers may find it difficult to adopt a new teaching approach because it requires background knowledge that they do not possess. Many argued that early childhood teachers should hold a bachelor degree in early childhood education or a closely related field in order to ensure that they possess sufficient background knowledge. An implicit assumption is that a teacher with the degree should have a higher productivity for the HighScope, and therefore should be able to adopt the more effective teaching approach with a reasonably low cost. In other words, lack of knowledge would raise the cost of adoption. Therefore, we should expect to see a positive and significant estimation coefficient of the dummy variable for having the degree.

In our data, almost 86% of the teachers had a bachelor degree and roughly 84% of them had a bachelor degree in early childhood education (mostly from a part-time program). Empirically, the estimated coefficients of the variable of interest are insignificant in all specifications. That is, there is no evidence suggesting that having a degree in early childhood education increases the likelihood to adopt the HighScope both ceremonially and with high fidelity. See the sixth row of Table 4-9. One potential explanation is that most of the teachers received the degree from part-time programs, which might not be effective enough. Alternatively, one could also argue that simply having knowledge would not make a difference. What we need is the right incentive. Unfortunately, we cannot yet tell which explanation is the right one.

Having a Bonus System to Drive Teacher Incentives

One way to drive an agent's incentives to put high effort is to pay her conditional on her performances. A bonus system is a popular performance-related pay system. In fact, many SAOs paid bonuses to their employees including early childhood teachers every year. The question here is whether teachers working in a SAO with a bonus system are more likely to adopt the HighScope? Conceptually, we expect to see a positive and significant estimation coefficient of the dummy variable for having a bonus system within the SAO.

According to our data, roughly 77% of the SAOs paid bonuses to their employees in 2014. The estimation coefficients for the bonus are in fact negatively insignificant for the ceremonial adoption while they are positive but not significant for teaching quality. Overall, we found no evidence showing that the bonus system of the SAOs significantly impacts the adoption behavior of the teachers. It seems puzzling at first. But recall from our qualitative analysis that most of the SAOs do not seem to have a good evaluation system. On the other hand, we know that the effectiveness of a bonus system relies on the quality of performance evaluation. Therefore, it is not so surprising to see that a bonus system of the SAOs would be ineffective without a good evaluation system.

Indebtedness of teachers

It has been a common belief in Thailand that one of the biggest problems in education is teacher indebtedness. Many argued that, with a large amount of debt, teachers may not be able to perform well in class because they may need to put the effort in other activities to generate additional income to repay their debts. Intuitively, more indebtedness could potentially affect the utility function of the teacher in such a way that the cost of effort for teaching is higher. Therefore, we would expect a negative correlation between the level of debt and the likelihood to adopt.

We now turn to the data. An average early childhood teacher in our study has more than 1 million Baht of household debt in 2015. The estimation coefficients for debt in Table 4-6 are not statistically significant. These imply that the amount of debt has no impact on the likelihood to adopt the plan-do-review in the classroom. Similarly, it has no significant effect on the teaching quality in all specifications. See Table 7-9. Overall, we found no evidence suggesting that household debt has significant influence on teacher adoption of the HighScope approach, both ceremonially and with high-fidelity.

Teacher Attitude toward Being an Early Childhood Teacher

Teacher attitude toward being an early childhood teacher should potentially affect teachers' preferences, which in turn determine their adoption choices. Teachers who have better attitude toward being an early childhood teacher should also have a relatively higher value toward children skills. As a result, they should be more likely to adopt a new and more effective approach. Therefore, we would expect a positive coefficient for the teacher attitude in the estimations.

Empirically, we first applied the principal component method to form a factor called "teacher attitude" using four hypothetical questions, which are presented in Appendix B. These four questions in fact lead to only one stable factor with the eigenvalue greater than one, and its factor loadings are all positive as anticipated. We therefore named this factor the teacher attitude. As anticipated, the estimation coefficients for the teacher attitude in Table 4-9 are negative. However, they are not significant in any specification. To be precise, we found no

evidence showing that teacher attitude can significantly increase the HighScope adoption both ceremonially and with high-fidelity.

The Local Tie: Teachers from the Local

Recently, the Thai government implemented a program to recruit teachers from the local areas under the program "Kru Kuen Tin". This must have been driven by the belief that a teacher who has a strong tie with the local community would care more about the children in the area and exert more effort than the others. According to our economic model, this local tie should affect the teachers' preferences in the same manner as the teacher's attitude. That is, a teacher with a stronger tie should put a higher value to children skills more than the others, and therefore are willing to apply the HighScope more. Therefore, we would expect a positive coefficient for the local tie in the estimations.

We here measured the local tie for a teacher by her birthplace. In particular, the variable will be one if the teacher was born in the same Tambon as the location of the childcare center where she was working. There were 82% of teachers with the local tie in our data. Importantly, the estimation results in Table 4-9 suggested that there was no evidence showing that the local tie has a positive impact on the adoption behavior. Specifically, the estimation coefficients for the high-fidelity adoption were all negative while the results for the ceremonial adoption were mixed. All results were not statistically significant.

Job Security

There have been an increasing interest in the effect of job security of teachers on education outcomes of the students. Atherton and Kingdon (2010), Duflo, Dupas, and Kremer (2012), and Muralidharan and Sundararaman (2013) consistently showed that contract teachers with not-too-secured contracts, less qualification and much-less salary can be as effective ascivil-service teachers with very-secured contracts, good qualification, and much-higher salary (about 5 times higher than the contract teachers). Likewise, in our case, a civil-service teacher may have less incentive to adopt new teaching technology because her job is already secured. Therefore, we would expect a negative coefficient for the civil-service teacher in the estimations.

We constructed the civil-service teacher variable as a dummy variable, whose value is one if the teacher is a civil-service teacher and zero otherwise. There were about 48% of local teachers as civil-service teachers. The estimation results in Table 4-9 showed that the estimation coefficients for the civil-service teacher were negative (as anticipated) but not significant. In other words, we found no evidence showing that being a government teacher with job security can increase the likelihood to adopt. This finding is consistent with Atherton and Kingdon (2010), Duflo, Dupas, and Kremer (2015), and Muralidharan and Sundararaman (2013) job security does not seem to lead to better quality.

4. Discussion and Future Research

Our qualitative and quantitative analyses converged in consensus that technology transfer is the most important factor that affects level of adoption. The qualitative analysis elaborated that it is not only technology transfer alone, but also another two mechanisms – reassurance and stakeholders' attention that are required for high-fidelity adoption. One of the mechanisms missing may result in a ceremonial adoption. Likewise, the quantitative analysis highlights the significance of technology transfer, yet providing a more nuanced view. Specifically, it shows that the transfer through co-teaching with RIECE teachers, not on-site training, affects high-fidelity adoption. This is interesting since many organizations and individuals, when implementing a new technology, often provide trainings in forms of one-time or series of workshops and/or on-site observation at entities believed to be the best models. This quantitative analysis posits that forms of technology transfer are also important and should not be taken lightly for high-fidelity adoption to succeed.

Although this research is still at the primary stage, this evolving study has aided in enhancing our understanding about technology adoption and so far improving our efforts in effective adoption of the HighScope in the fieldwork. Thanks to the joint forces of economics and management, we believe that the use of multiple scientific disciplines and various methods together can help produce powerful insight that has impact on both the academic and practical

world. Lastly, we posit that adoption of tangible technology and process technology is different. Process technology is more ambiguous, and requires more focus on knowledge transfer and formation of tacit knowledge.

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Table 4: Estimation result for the ceremonial adoption with the on-site training defined at the individual level

VARIABLES	(1) pdr	(2) pdr	(3) pdr	(4) pdr	(5) pdr	(6) pdr	(7) pdr	(8) pdr
Age	0.512***	0.533***	0.459*	0.477**	0.494*	0.456*	0.486*	0.486*
	(0.188)	(0.196)	(0.236)	(0.243)	(0.258)	(0.268)	(0.275)	(0.273)
Age squared	-0.00625***	-0.00650***	-0.00547**	-0.00566**	-0.00587**	-0.00555*	-0.00590*	-0.00591*
	(0.00221)	(0.00232)	(0.00274)	(0.00280)	(0.00297)	(0.00311)	(0.00319)	(0.00316)
Student-teacher ratio	-0.0612*	-0.0735**	-0.0609*	-0.0616*	-0.0612*	-0.0362	-0.0425	-0.0431
	(0.0333)	(0.0353)	(0.0348)	(0.0349)	(0.0349)	(0.0405)	(0.0409)	(0.0410)
Riece teacher dummy	0.279	0.225	0.399	0.404	0.418	0.425	0.370	0.366
	(0.310)	(0.314)	(0.335)	(0.333)	(0.336)	(0.341)	(0.340)	(0.348)
On-site training	0.603	0.999	1.030	1.022	1.044	0.958	1.003	1.000
	(0.522)	(0.658)	(0.670)	(0.676)	(0.687)	(0.654)	(0.673)	(0.679)
Early childhood degree	0.368	0.364	-0.0207	-0.0201	-0.0242	0.0357	0.179	0.181
	(0.374)	(0.387)	(0.481)	(0.475)	(0.482)	(0.480)	(0.510)	(0.513)
Having bonus 2014		-0.0309	-0.0221	-0.0403	-0.0537	-0.0600	-0.0344	-0.0353
		(0.405)	(0.403)	(0.399)	(0.404)	(0.435)	(0.451)	(0.449)
Teacher indebtedness			-0.0972	-0.103	-0.110	-0.0199	-0.0203	-0.0161
			(0.118)	(0.117)	(0.114)	(0.130)	(0.187)	(0.191)
Teacher attitude				-0.0837	-0.0843	-0.0882	-0.134	-0.133
				(0.241)	(0.244)	(0.261)	(0.259)	(0.259)
Local tie					-0.144	-0.0843	0.0800	0.0784
					(0.509)	(0.498)	(0.511)	(0.510)
Having a co-teacher						0.453	0.509	0.509
						(0.397)	(0.404)	(0.402)
Being a civic service							-0.344	-0.348
							(0.415)	(0.416)
Believe in homework								-0.0634
								(0.344)
Constant	-8.866**	-9.064**	-7.744	-8.118*	-8.333	-8.096	-8.715	-8.662
	(3.772)	(3.941)	(4.742)	(4.931)	(5.068)	(5.466)	(5.653)	(5.686)
Observations	105	102	86	86	86	84	81	81

Robust standard errors in parentheses and *** p<0.01, ** p<0.05, * p<0.1.

Table 5: Estimation result for the ceremonial adoption with the on-site training dummy defined at the center level

VARIABLES	(1) pdr	(2) pdr	(3) pdr	(4) pdr	(5) pdr	(6) pdr	(7) pdr	(8) pdr
Age	0.573***	0.591***	0.476**	0.502**	0.499**	0.467*	0.471*	0.479*
	(0.176)	(0.178)	(0.219)	(0.227)	(0.238)	(0.263)	(0.262)	(0.271)
Age squared	-.00684***	-0.00705***	-0.00561**	-0.00587**	-0.00584**	-0.00558*	-0.00563*	-0.00571*
	(0.00208)	(0.00211)	(0.00254)	(0.00262)	(0.00275)	(0.00304)	(0.00304)	(0.00312)
Student-teacher ratio	-0.0548*	-0.0625*	-0.0507	-0.0514	-0.0516	-0.0242	-0.0272	-0.0267
	(0.0326)	(0.0348)	(0.0348)	(0.0346)	(0.0345)	(0.0419)	(0.0413)	(0.0411)
Riece teacher dummy	1.085*	1.446**	1.472**	1.518**	1.518**	1.984**	1.897**	1.985**
	(0.555)	(0.717)	(0.713)	(0.713)	(0.712)	(0.872)	(0.864)	(0.905)
On-site training	1.125**	1.699**	1.616**	1.657**	1.659**	2.081**	2.045**	2.143**
	(0.564)	(0.731)	(0.718)	(0.712)	(0.712)	(0.881)	(0.868)	(0.906)
Early childhood degree	0.303	0.329	0.000145	0.000826	0.000781	-0.00728	0.105	0.0826
	(0.353)	(0.356)	(0.428)	(0.416)	(0.416)	(0.441)	(0.485)	(0.490)
Having bonus 2014		-0.629	-0.569	-0.610	-0.608	-0.628	-0.630	-0.648
		(0.643)	(0.591)	(0.586)	(0.587)	(0.539)	(0.566)	(0.586)
Teacher indebtedness			-0.0113	-0.0217	-0.0200	0.0733	0.0712	0.0624
			(0.116)	(0.113)	(0.111)	(0.122)	(0.183)	(0.187)
Teacher attitude				-0.138	-0.138	-0.127	-0.165	-0.167
				(0.239)	(0.238)	(0.259)	(0.256)	(0.262)
Local tie					0.0303	0.0178	0.143	0.149
					(0.475)	(0.489)	(0.514)	(0.511)
Having a co-teacher						0.594	0.644	0.640
						(0.419)	(0.427)	(0.435)
Being a civic service							-0.238	-0.222
							(0.437)	(0.446)
Believe in homework								0.180
								(0.374)
Constant	-11.26***	-11.40***	-9.156**	-9.758**	-9.730**	-10.05*	-10.14*	-10.54*
	(3.661)	(3.687)	(4.484)	(4.744)	(4.842)	(5.610)	(5.647)	(5.959)
Observations	105	102	86	86	86	84	81	81

Robust standard errors in parentheses and *** p<0.01, ** p<0.05, * p<0.1.

Table 6: Estimation result for the ceremonial adoption with the on-site training variable defined as the ratio of all teachers at the center

VARIABLES	(1) pdr	(2) pdr	(3) pdr	(4) pdr	(5) pdr	(6) pdr	(7) pdr	(8) pdr
Age	0.535***	0.547***	0.424*	0.447*	0.445*	0.446	0.478*	0.497*
	(0.180)	(0.184)	(0.223)	(0.229)	(0.243)	(0.279)	(0.280)	(0.294)
Age squared	-.00650***	-0.00672***	-0.00514**	-0.00536**	-0.00534*	-0.00557*	-0.00595*	-0.00613*
	(0.00212)	(0.00218)	(0.00258)	(0.00264)	(0.00280)	(0.00323)	(0.00326)	(0.00341)
Student-teacher ratio	-0.0619*	-0.0720*	-0.0542	-0.0547	-0.0548	-0.00848	-0.0132	-0.0134
	(0.0350)	(0.0392)	(0.0377)	(0.0376)	(0.0374)	(0.0471)	(0.0463)	(0.0456)
Riece teacher dummy	1.092**	1.196**	1.338**	1.364**	1.364**	1.927***	1.929***	2.041***
	(0.444)	(0.487)	(0.548)	(0.545)	(0.545)	(0.587)	(0.600)	(0.651)
On-site training	0.0340***	0.0429***	0.0413***	0.0419***	0.0419***	0.0552***	0.0572***	0.0605***
	(0.0118)	(0.0138)	(0.0138)	(0.0137)	(0.0136)	(0.0154)	(0.0156)	(0.0170)
Early childhood degree	0.376	0.433	0.154	0.165	0.166	0.221	0.410	0.376
	(0.370)	(0.387)	(0.462)	(0.452)	(0.452)	(0.489)	(0.515)	(0.528)
Having bonus 2014		-0.507	-0.493	-0.528	-0.527	-0.579	-0.596	-0.590
		(0.546)	(0.532)	(0.526)	(0.526)	(0.508)	(0.533)	(0.534)
Teacher indebtedness			-0.0143	-0.0239	-0.0229	0.0997	0.117	0.101
			(0.115)	(0.113)	(0.111)	(0.125)	(0.184)	(0.185)
Teacher attitude				-0.131	-0.132	-0.143	-0.208	-0.210
				(0.249)	(0.249)	(0.294)	(0.291)	(0.300)
Local tie					0.0164	0.0545	0.213	0.224
					(0.509)	(0.498)	(0.514)	(0.512)
Having a co-teacher						0.914**	1.007**	1.020**
						(0.451)	(0.454)	(0.472)
Being a civic service							-0.408	-0.398
							(0.423)	(0.427)
Believe in homework								0.271
								(0.378)
Constant	-10.19***	-9.960***	-7.823*	-8.340*	-8.317*	-9.751	-10.52*	-11.24*
	(3.597)	(3.671)	(4.494)	(4.710)	(4.858)	(5.960)	(6.052)	(6.495)
Observations	105	102	86	86	86	84	81	81

Robust standard errors in parentheses and *** p<0.01, ** p<0.05, * p<0.1.

Table 7: Estimation result for the high-fidelity adoption (teaching quality) with the on-site training defined at the individual level

VARIABLES	(1) quality	(2) quality	(3) quality	(4) quality	(5) quality	(6) quality	(7) quality	(8) quality
Age	0.387**	0.349**	0.311	0.320	0.405*	0.376	0.379	0.377
	(0.160)	(0.158)	(0.194)	(0.200)	(0.212)	(0.230)	(0.238)	(0.242)
Age squared	-0.00458**	-0.00404**	-0.00362	-0.00373	-0.00473*	-0.00442	-0.00446	-0.00444
	(0.00191)	(0.00190)	(0.00230)	(0.00236)	(0.00250)	(0.00270)	(0.00280)	(0.00285)
Student-teacher ratio	0.0204	0.0191	0.00509	0.00482	0.0111	0.0149	0.0149	0.0145
	(0.0299)	(0.0314)	(0.0357)	(0.0358)	(0.0351)	(0.0416)	(0.0420)	(0.0423)
Riece teacher dummy	0.512*	0.534*	0.721**	0.723**	0.812**	0.783**	0.784**	0.769**
	(0.282)	(0.285)	(0.303)	(0.304)	(0.311)	(0.325)	(0.329)	(0.356)
On-site training	0.206	0.305	0.607	0.605	0.608	0.572	0.574	0.568
	(0.382)	(0.386)	(0.421)	(0.424)	(0.410)	(0.436)	(0.439)	(0.447)
Early childhood degree	-0.109	-0.107	-0.295	-0.285	-0.257	-0.268	-0.259	-0.256
	(0.344)	(0.347)	(0.334)	(0.336)	(0.343)	(0.354)	(0.392)	(0.398)
Having bonus 2014		0.165	0.263	0.253	0.224	0.175	0.181	0.186
		(0.386)	(0.403)	(0.415)	(0.428)	(0.448)	(0.466)	(0.479)
Teacher indebtedness			-0.0993	-0.0999	-0.0795	-0.0374	-0.0334	-0.0303
			(0.138)	(0.140)	(0.143)	(0.177)	(0.195)	(0.200)
Teacher attitude				-0.0361	-0.0825	-0.0838	-0.0834	-0.0802
				(0.208)	(0.209)	(0.210)	(0.212)	(0.215)
Local tie					-0.583	-0.569	-0.566	-0.556
					(0.484)	(0.505)	(0.508)	(0.524)
Having a co-teacher						0.0225	0.0265	0.0343
						(0.392)	(0.402)	(0.411)
Being a civic service							-0.0239	-0.0326
							(0.394)	(0.407)
Believe in homework								-0.0578
								(0.345)
Constant	-6.798**	-6.294**	-5.084	-5.286	-6.637	-6.047	-6.115	-6.042
	(3.197)	(3.148)	(3.865)	(4.014)	(4.035)	(4.579)	(4.781)	(4.884)
Observations	89	87	72	72	72	71	71	71
R-squared	0.105	0.106	0.124	0.125	0.143	0.121	0.121	0.121

Robust standard errors in parentheses and *** p<0.01, ** p<0.05, * p<0.1.

Table 8: Estimation result for the high-fidelity adoption (teaching quality) with the on-site training dummy defined at the center level

VARIABLES	(1) quality	(2) quality	(3) quality	(4) quality	(5) quality	(6) quality	(7) quality	(8) quality
Age	0.406***	0.367**	0.308*	0.321*	0.400*	0.370	0.369	0.369
	(0.150)	(0.149)	(0.182)	(0.189)	(0.209)	(0.226)	(0.233)	(0.238)
Age squared	-0.00473**	-0.00420**	-0.00356	-0.00370	-0.00464*	-0.00432	-0.00431	-0.00431
	(0.00180)	(0.00179)	(0.00217)	(0.00223)	(0.00246)	(0.00265)	(0.00275)	(0.00281)
Student-teacher ratio	0.0196	0.0181	0.0125	0.0121	0.0183	0.0206	0.0206	0.0205
	(0.0293)	(0.0299)	(0.0349)	(0.0347)	(0.0343)	(0.0436)	(0.0442)	(0.0443)
Riece teacher dummy	1.067**	1.104**	1.058**	1.064**	1.114**	1.039*	1.039*	1.031
	(0.468)	(0.468)	(0.510)	(0.521)	(0.549)	(0.587)	(0.590)	(0.667)
On-site training	0.727	0.795	0.597	0.600	0.558	0.491	0.491	0.484
	(0.459)	(0.479)	(0.518)	(0.525)	(0.549)	(0.598)	(0.602)	(0.650)
Early childhood degree	-0.167	-0.143	-0.264	-0.250	-0.221	-0.232	-0.234	-0.233
	(0.327)	(0.333)	(0.339)	(0.339)	(0.338)	(0.347)	(0.383)	(0.387)
Having bonus 2014		-0.0553	0.144	0.129	0.114	0.0820	0.0807	0.0836
		(0.409)	(0.417)	(0.435)	(0.440)	(0.453)	(0.471)	(0.509)
Teacher indebtedness			-0.0299	-0.0306	-0.0145	0.0215	0.0206	0.0209
			(0.139)	(0.140)	(0.141)	(0.162)	(0.183)	(0.186)
Teacher attitude				-0.0484	-0.0915	-0.0913	-0.0914	-0.0906
				(0.215)	(0.219)	(0.220)	(0.222)	(0.226)
Local tie					-0.546	-0.534	-0.535	-0.533
					(0.497)	(0.517)	(0.522)	(0.531)
Having a co-teacher						0.00231	0.00141	0.00329
						(0.394)	(0.402)	(0.417)
Being a civic service							0.00541	0.00329
							(0.400)	(0.411)
Believe in homework								-0.0134
								(0.367)
Constant	-7.864**	-7.143**	-5.564	-5.838	-7.074*	-6.381	-6.366	-6.343
	(3.052)	(3.007)	(3.727)	(3.912)	(4.073)	(4.607)	(4.814)	(4.985)
Observations	89	87	72	72	72	71	71	71
R-squared	0.127	0.124	0.115	0.115	0.132	0.109	0.109	0.109

Robust standard errors in parentheses and *** p<0.01, ** p<0.05, * p<0.1.

Table 9: Estimation result for the high-fidelity adoption (teaching quality) with the on-site training variable defined as the ratio of all teachers at the center

VARIABLES	(1) quality	(2) quality	(3) quality	(4) quality	(5) quality	(6) quality	(7) quality	(8) quality
Age	0.370**	0.335**	0.276	0.292	0.373*	0.350	0.354	0.354
	(0.157)	(0.156)	(0.185)	(0.191)	(0.209)	(0.225)	(0.233)	(0.236)
Age squared	-0.00439**	-0.00391**	-0.00323	-0.00342	-0.00438*	-0.00414	-0.00419	-0.00419
	(0.00187)	(0.00187)	(0.00220)	(0.00226)	(0.00246)	(0.00265)	(0.00275)	(0.00280)
Student-teacher ratio	0.0173	0.0170	0.0108	0.0101	0.0163	0.0235	0.0236	0.0236
	(0.0296)	(0.0308)	(0.0354)	(0.0351)	(0.0347)	(0.0414)	(0.0420)	(0.0422)
Riece teacher dummy	0.870**	0.853**	0.989**	1.003**	1.065**	1.036**	1.038**	1.040*
	(0.379)	(0.378)	(0.444)	(0.452)	(0.471)	(0.490)	(0.504)	(0.557)
On-site training	0.0144	0.0141	0.0136	0.0139	0.0132	0.0127	0.0128	0.0128
	(0.00974)	(0.00987)	(0.0108)	(0.0109)	(0.0112)	(0.0118)	(0.0122)	(0.0128)
Early childhood degree	-0.0807	-0.0631	-0.189	-0.170	-0.145	-0.162	-0.149	-0.149
	(0.340)	(0.348)	(0.340)	(0.339)	(0.345)	(0.360)	(0.403)	(0.407)
Having bonus 2014		0.0531	0.184	0.161	0.142	0.0955	0.102	0.102
		(0.388)	(0.404)	(0.422)	(0.428)	(0.437)	(0.454)	(0.483)
Teacher indebtedness			-0.0376	-0.0380	-0.0206	0.0193	0.0250	0.0249
			(0.138)	(0.140)	(0.141)	(0.163)	(0.184)	(0.187)
Teacher attitude				-0.0669	-0.109	-0.112	-0.112	-0.112
				(0.215)	(0.218)	(0.217)	(0.218)	(0.223)
Local tie					-0.549	-0.539	-0.536	-0.536
					(0.491)	(0.511)	(0.517)	(0.524)
Having a co-teacher						0.0815	0.0875	0.0873
						(0.389)	(0.397)	(0.405)
Being a civic service							-0.0327	-0.0324
							(0.402)	(0.411)
Believe in homework								0.00239
								(0.354)
Constant	-6.796**	-6.210**	-4.767	-5.132	-6.419	-5.994	-6.087	-6.091
	(3.099)	(3.088)	(3.697)	(3.868)	(3.985)	(4.507)	(4.736)	(4.849)
Observations	89	87	72	72	72	71	71	71
R-squared	0.124	0.119	0.118	0.119	0.136	0.114	0.114	0.114

Robust standard errors in parentheses and *** p<0.01, ** p<0.05, * p<0.1.

Appendix A: Interview protocol (SAO chief executives, SAO education officers, and local teachers)

1. What was your reaction when you were first approached by the RIECE team?
2. What do you think about HighScope? Why did you decide to adopt it?
3. What is normally going on in class?
4. After adoption the HighScope, what do you think about the practice?
5. Are there any problems, pressures, obstacles, or difficulties for implementing the HighScope?
6. To what extent do you think you understand HighScope?
7. Any difference in kids before and after the adoption of HighScope?
8. [For SAO chiefs executives and officers], what is the goal of your SAO? [For local teachers], what is the goal of your preschools?
9. Is HighScope effective? How might it be improved?
10. In your opinion, why do some preschools adopt HighScope partially?

Addition questions to SAO chief executives and educational officers:

1. Why did you decide to adopt HighScope? Why change?
2. What is your vision for early childhood education?
3. Will you continue adopting HighScope, even though one day the RIECE program is ended? Why?

Appendix B: Questions regarding teacher attitude toward being an early childhood teacher

1. I enjoy with my teaching.
2. I am confident that my teaching will make the student's life better.
3. If I could restart my life, I still going to be an early childhood teacher.
4. I chose to be an early childhood teacher because it is my dream since I was young.