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Adoption and Diffusion of Information Technology in Early Childhood Pedagogy: Crossing the Invisible Chasm

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Abstract

On a global basis, the usage of information technology in childhood pedagogy has been controversial. However, the trend of utilizing computers in preschool education is likely to gain momentum regardless of this controversy. This is particularly so for Singapore, a tiny country ranked only second to the United States in IT penetration and usage in the latest ranking by the World Economic Forum. In this regard, the attitudes of the various stakeholders (principals/administrators, teachers, and parents/guardians) are of utmost concern to both researchers and practitioners as such attitudes may shape the styles and methods of IT usage. Based on symbolic interactionism as the informing theoretical perspective, this study examines their perceptions toward IT usage in childhood pedagogy at seven preschool educational centers in Singapore. As part of our findings, we identify the existence of an "invisible" chasm and highlight factors that may be critical in crossing this chasm. In particular, we suggest possible extensions to Surry's RIPPLES model, originally based on higher education, with accompanying implications for future research. We conclude with a proposed PIECES framework to guide effective IT usage in early childhood pedagogy.

Keywords: IT adoption, IT diffusion, childhood pedagogy, symbolic interactionism

Introduction

Controversy Regarding Information Technology Usage in Early Childhood Pedagogy

On a global basis, the usage of information technology in childhood pedagogy has been controversial. On one hand, IT brings about benefits such as heightened level of fun and entertainment during learning, creativity, and early exposure but, on the other, potential problems like health (deterioration of eyesight, posture problems) and social (addiction, selfishness) risks. This is even more crucial with younger children, since such usage is bound to have an impact on their future development and, as a result, consequential implications to our society. For people without a clear stand on whether such usage is more advantageous or disadvantageous, some are concerned about whether such technologies are economically justifiable as pedagogical tools (Healy 1998) while others are more non-committal. For example, Van Scoter et al. (2001) recognize the benefits of such usage but suggest that "computer use is and should be relatively brief at this age, and limiting screen time and encouraging frequent breaks will decrease the risks" (p. 11). It seems that the general consensus of most is that technology can be quite useful and practical, but not definitely necessary for children before formal (grade school) education.

The Singapore Context: An Invisible Chasm?

The non-committal attitude above is particularly striking in Singapore, a country which prides itself in having planned for everything and where governmental intervention in many sectors of the economy and society at large are generally accepted.

While there are prescribed educational and IT policies for formal education from primary (grade school) to tertiary levels by the Ministry of Education (MOE 1997), it is surprising that there are no fixed IT guidelines across the board for the preschools (PSE 2003), which is the last step prior to the beginning of formal education. Considering Singapore's well-known reputation as a centrally controlled "nanny state" (FitzPatrick 2003) and it being ranked second only to the United States in IT usage (*Straits Times* 2003), such a state of affairs deserves due consideration.

Statistics in the year 2003 show that 95 percent of kindergartens in Singapore are equipped with computer-aided education (CAE), first introduced in 1992. Applying Roger's (1995) diffusion curve to the usage of CAE in Singapore preschools, it is apparent that Moore's (1991) chasm between early adopters and early majority has long been crossed. However, it is perplexing to see a number of large preschool operators in Singapore running some of their centers with IT-supported programs and some centers without. Are there less visible chasms which have not been crossed or are difficult to cross?

Focus and Roadmap of the Paper

Prompted by our awareness of such undercurrents that may be at work, this study examines the perceptions of various stakeholders (preschool operators, administrators, teachers, and parents/guardians) through empirical data collected at seven selected preschool centers in Singapore. Based on symbolic interactionism as the informing theoretical perspective, we study how these stakeholders are shaping the styles and methods of IT used today. As part of our findings, we identify the existence of an invisible chasm and suggest factors critical in crossing this chasm. In particular, we extend Surry's RIPPLES model (Surry 2002; Surry et al. 2003), originally based on higher education, to apply it to the preschool context. We conclude with a suggested framework for effective IT usage in early childhood pedagogy.

Literature Review

Pedagogical Theory in Support of IT Usage for Instruction in Preschools

The constructivism learning theory is a well-known guiding philosophy to educate children in today's age of information as many educators and cognitive psychologists have applied constructivism to the development of learning environments (Ferguson 2001). Constructivists who support the use of computers in early childhood contend that the "concrete objects" children manipulate can just as well be figures on the computer screen (Van Scoter et al. 2001). Children learn what is necessary to participate within their society and culture through interactions with cultural tools that are mediated by peers and adults (Vygotsky 1978). The major theme of Vygotsky's theoretical framework is that learning is a social process and social interaction plays a fundamental role in the development of cognition. Learning is best accomplished when opportunities for collaboration and cooperation are part of the classroom's routines. According to Crook (1996), collaboration is central to the cultural approach in the same way that construction is central to the constructivist tradition. Crook also added that computers can play an effective role in the support of this collaboration. Many researchers saw a strong support of constructivist learning principles in IT-based learning environments (Ferguson 2001). The unique capabilities of IT make it a particularly useful tool for constructive learning (Roschelle et al. 2000). Several studies in this area suggest that computers have been found to promote significant social-emotional, language, and cognitive growth when successfully integrated into developmentally appropriate classrooms (NAEYC 1998). Research has also shown that 3- and 4-year-old children who use computers with supporting activities that reinforce the major objectives of the programs have significantly greater developmental gains when compared to children without computer experiences in similar classrooms (Haugland 1992).

Pedagogical Theory Against IT Usage for Instruction in Preschools

On the other hand, some researchers and practitioners have doubts about the value of computers in early childhood education. Critics advocate that the basic truth in education is that a child must be literate before he/she is computer literate. They believe that putting children in front of a computer is depriving them of something very important that they can't get back (Seltz 1999). Koh (1999), principal of Pat's Schoolhouse in Singapore, having dedicated 30 years of her life teaching and reaching out to thousands of young children, warns that introducing computers to children under the age of 5 may lead to early childhood autism. Healy, an educational psychologist as well as an educator and author argues that using computers at too young an age can harm a child's intellectual development, stifle creativity, and decrease attention span. She recommends against any computer use until

age 7 (Healy 1998; Seltz 1999). In fact, educators and parents are now finding disturbing data which, at the very least, cast doubt on the assumption that computers play a valuable role in early primary grades (*Realworld* 2004).

Symbolism at Work?

Against this backdrop, anecdotal evidence reveals that the practitioners and stakeholders involved have varying perceptions regarding this issue. Such perceptions may be founded based on many factors, including their own interactions with computers and/or with others holding strong opinions for or against such usage in early childhood pedagogy. On reflection, the contrasting opinions of various stakeholders may be due to the symbolic nature of computers, a subject of growing research interest in recent years (Prasad 1993). Symbols give meaning to what is perceived. Identifying and interpreting symbols is thus likely to illuminate the deep underlying meaning within them (Hirschheim and Newman 1991). In turn, appreciating the symbolism and meanings that the various stakeholders of preschool centers attribute to such IT usage in early childhood pedagogy may allow us to gain fruitful and interesting insights into their perceptions which may in turn motivate their subsequent actions. Toward this end, symbolic interactionism, a largely underutilized perspective in IS research, may be particularly appropriate as a theoretical lens for our study.

Symbolic Interactionism

Symbolic interactionism is an interpretive approach to understanding human group life and is built largely upon the ideas of George Herbert Mead (1934). A student of Mead, Herbert Blumer (1969), drew out the fuller implications of Mead's works and was responsible for coining the term *symbolic interactionism*. Blumer synthesized and developed the theoretical and methodological significance of Mead's ideas for the social sciences (Prus 1996) and in the process of formulating symbolic interactionism, he laid down three assumptions that form the basis of the approach:

- "that human beings act toward things on the basis of the meanings that these things have for them"
- "that the meaning of such things is derived from, and arises out of, the social interaction that one has with one's fellows"
- "that these meanings are handled in, and modified through, an interpretive process used by the person in dealing with the things he encounters" (Blumer 1969, p. 2)

From these assumptions, it follows that symbolic interactionism acknowledges the interpretive and interactive essences of people's lived experience which makes possible intimate familiarity with the subject matter. These interpretations and interactions are realized primarily with the use of the shared symbols of language which, in symbolic interactionism, is a special kind of symbol that is in essence a set of words used for communication and representation (Charon 2001). Words, both spoken and written, are not just symbols but are also the basis of all other symbols. Thus, words and therefore language can be regarded as the most important symbols since all symbolic communication systems can only be interpreted with the use of language.

In the context of utilizing symbolic interactionism in organizational settings, symbolic interactionism rests upon an assumption that every organizational situation is most likely to be interpreted differently by different individuals (Prasad 1993). In reality, in their daily activities, the various stakeholders from the preschools faced with different situations and events would have to make sense of and deal with them as appropriate. Thus, the symbolic representations of the multiple perceptions that these stakeholders display will reveal meanings that are deeply embedded within them. This will consequently enhance our understanding of the subject matter, which in this case is IT usage in early childhood pedagogy, through the strong theoretical insights that symbolic interactionism offers.

Research Study

Research Questions

In this study, we seek to address the following questions:

- What are the factors impacting the adoption and diffusion of IT in childhood pedagogy in preschools?
- What measures can be taken to ensure more effective IT usage for instruction in these preschools?

Research Site: Background Context

This study takes place in Singapore, where the preschool education system involves both kindergartens and childcare centers for children aged between 18 months and 6 years old. Kindergartens operate a three-year structured program under K1, K2, and nursery classes while childcare centers operate mainly playgroups and nursery classes but may also operate K1 and K2 classes albeit on at a much smaller scale. Compulsory education in Singapore starts from Primary (Grade) One at the age of 6 or above. Almost all children entering primary schools graduate from kindergartens. Kindergartens are regulated by the Ministry of Education (MOE) but childcare centers are under the purview of the Ministry of Community and Development. All preschool centers are run by the private sector, including community foundations, religious bodies, social organizations, and business organizations. Additionally, there are foreign systems or international schools that offer preschool programs for children of expatriate families.

The Case Study Organizations

We focus our study on the kindergartens as they are the mainstream of the preschools and are more prevalent in the use of IT in pedagogy. It is important to note that a kindergarten operator equipped with CAE does not mean that all of its centers are likewise equipped, especially for a large operator having hundreds of centers. Moreover, a center with CAE does not imply that all of the children enrolled in the center are having CAE classes. For smaller operators such as a single center operation, the selection for our site study is relatively easy. For large operators, we started with a careful selection of their centers with the assistance of their chief executives at their operational headquarters. The center selection criteria include the level of IT usage in pedagogy (or non-usage), the teaching styles or cultures (e.g., community foundation, church, clan associations, or pure commercial entity), and the location, accessibility, and surrounding economy (e.g., upmarket, heartland, business districts). Altogether seven centers were thus selected.

Research Methodology

Using symbolic interactionism as the informing theoretical perspective, we conducted a case study of these seven kindergarten centers in Singapore. We visited all of the selected centers during their class sessions to facilitate observation and interviews with various stakeholders. More importantly, we spent significant time at each center over several visits to understand the ongoing social interactions. For example, we closely observe the children's learning progress while attending computer vis-a-vis non-computer based lessons, and during such sessions, interactions among the children and with their teachers were recorded. There were between 6 and 10 interviewees per center visited, grouped separately under principals/administrators, teachers, and parents/children. The first two groups were interviewed directly while children were selectively interviewed but mostly observed as they may be too young to be held accountable for their responses. Views from parents/guardians were thus also recorded to complement their children's views whenever available. Eighteen open-ended probing questions (see Appendix A for some selected samples) were used to steer the respondents toward the research questions involved, but not to influence their opinions. As conversations were not restricted to pre-drawn topics, upon relevancy in responses, impromptu questions were also frequently asked to solicit further opinions to build up depth in the answers.

Some related data were collected from the MOE and from centers not visited through the headquarters of their operators. Intense field work was carried out from May to August 2003. Additional information gathering, clarification, and follow-up work with the centers and their headquarters continued while our report took shape from September 2003 until March 2004.

Interviews from the site visits of the kindergarten centers were first transcribed on paper, and then compared alongside one another for emerging themes. A typology of observation processes was used to progressively guide us in focusing the observations in the field (Werner and Schoepfle 1987). Guided by the symbolic interactionist approach, the data analysis process was based on the analytic practices of Emerson et al. (1995), which are informed by the interactionist perspective. Certain keywords frequently repeated in the interviews and our fieldnotes were coded to generate and construct the main themes, which in turn provided the premise for our eventual findings.

Research Findings

Through the site visits, we categorize the principals, administrators, and teachers into supporters and non-supporters of IT usage in childhood pedagogy. The supporters are those who pride themselves as users. They believe that children can be exposed to and will benefit from computers at this age and that the rest of the non-adopters will gradually become adopters. The non-supporters, albeit a much smaller group, are those who are skeptical in their views about children using computers for learning. To them, kindergarten education should be built on a foundation of physical and moral learning activities. They also fear that health risks (posture and eyesight), addiction to computer games, and lack of social skills may result. Parents/guardians and children are grouped separately in this study.

The Supporters

"Pride in being one of the pioneers." Using Rogers's (1995) diffusion curve as a basis for our findings, this supporters group consists mainly of the innovators, early adopters, and early majority. Some were from prestige centers which initially adopted computers more for reasons of providing an exclusive service for competitive advantage as they usually charge higher fees and follow a niche marketing approach. Many feel proud to be associated with the pioneer users:

> *Our center started CAE as early as 1992 while some other centers of our [same] kindergarten are still not using computers today.*

> *We follow the pioneers in response to the government's call for IT literacy and promotion of e-learning.*

Although stakeholders from the early majority do not seem to have specific or common reasons for adopting CAE in their centers, they all generally hold a more affirmative view regarding pedagogic IT use for children. All principals and teachers interviewed from this supporters group believe that technology helps children in improving some academic and fine motor skills, as learning can be made more interesting and fun. In fact, these centers, conducting between two to four hours of computer lessons per week for each student enrolled under CAE classes, encourage parents to continue such usage with their children at home.

"Young children just love computers." The supporters appear to know best what most interests the children. They use computer usage as a reward tool to encourage good behavior:

> *Children who submit their homework on time and are well-disciplined will get freedom in choosing whatever games they might want to play during a computer lesson.*

As a reward, children get to choose to surf child-related sites such as Neopets and Disney.com instead of having to stick with arithmetic or phonics software. The following sentiment was echoed by a number of teachers:

> *Children get so excited whenever it is time for computer lessons! They ask if they can stay longer in the computer room next time!*

"Affordability is an obstacle." Given the fact that IT investments can be quite costly compared to traditional teaching media, it is understandable that financial resources and pricing of school fees could be major obstacles to IT usage as all of the kindergartens in Singapore are privately run and none of them publicly funded. Indeed, all respondents confirmed the importance of financial resources and the impact of such investments on school fees. It appears that the difference in economic status of working-class "heartlanders" (CDC 2000) vis-a-vis well-to-do cosmopolitan families can influence the choice of the kindergarten or its center or the type of class (with or without CAE for a different fee) enrolled in the center and, therefore, the opportunity for the child to experience CAE in learning. One practitioner's words confirm this position:

> *We cater to the heartlanders, we cannot just raise our school fees to fund our IT investments. Affordability of the families is our top concern.*

"Impact on teacher-children relationship." All practitioners interviewed agreed on the importance of the educator's role, especially in early childhood education.

> *We believe in the concept of scaffolding, the child already know something but a teacher can bring it to a higher level through computers. The benefits from the additional [school] fees are worthwhile.*

Teacher's supervision is seen as a critical aspect in children's interactions with computers, especially on the Internet where children may bump into inappropriate content. In all of the centers observed, CAE learning takes place inside a computer room and is led by the class teacher who organizes the core learning activities. The class teacher acts much like the form teacher in formal education. The teacher is no longer exclusively a source of information and has become a guide or adviser with the necessary knowledge to support children's learning. Teachers need to be trained to adjust to this role change. Although PSE (2003) has realized the importance of educator's training and has started to encourage and facilitate this by providing several training courses since the beginning of 2004, there is as yet no special training course offered on preschool IT usage in pedagogy. Teachers not only need to be computer literate, teachers also need to possess knowledge of how to make the technology usage developmentally appropriate for young children. Our findings indicate that there is a lack of this perspective and this has proven to be detrimental to the success of some initiatives. It is typical that teachers are self-taught in the implementation of CAE. This can be summed up from one practitioner's laid-back attitude:

> *We are all computer literate, the software is easy to use and we can operate them well without any training.*

"Technical support is a must." Findings show that technical support is one of the crucial factors in effective use of IT by most practitioners. No matter how good technology is, practitioners will choose to abandon it if it is unreliable (Ringstaff and Kelley 2002). The fact that CAE is conducted in a separate classroom with specific timing constraints makes technical reliability a pressing issue. Due to the children's enthusiasm regarding CAE, failure to keep the computers in working condition causes frustration to the children and teachers alike. Therefore, each implementation of CAE has to be supplemented with constant availability of technical support resources but this is lacking at present as computer classes are not important or non-existent in kindergarten classes. One teacher felt annoyed, helpless, and bemused at the whole situation:

> *Children are so disappointed whenever the computers are down! They always pester for make-up sessions!*

The Non-Supporters

"Affordability is an obstacle." Looking from a clearly different perspective, the non-supporters questioned the cost-benefit equation of using computers in early childhood pedagogy:

> *Computers are expensive toys. The extra school fees parents paid for are not worth it. What about those who can't afford it? Our funds are used in a more meaningful way in providing children with people and communication skills such as engaging renowned educators to come and interact with our children.*
>
> *Do you know what other centers are doing? Buying those computers is just like throwing away parents' money. Not every family can afford it. Their school fees are so much higher.*

"Impact on teacher-children relationship." Many non-supporters were strongly opposed to the use of computers in pedagogy due to the possible negative implications such as addiction to computer usage and reduced socialization with other children. A teacher lamented,

> *Our principal shares the same view as the Pat's Schoolhouse's principal….Introducing computers to children under the age of five may lead to early childhood autism."*

One center's principal was particularly adamant:

> *Teachers are role models for young children. What can computers serve them? Kindergarten education should be built on a foundation of physical and moral learning activities, like song and dance, or social skills like courtesy, sharing, and meal etiquette. We should not introduce academic-related lessons like language and arithmetic to children below the age of six, let alone computers.*

Children and Their Parents/Guardians

"Pride in being one of the pioneers." Children in CAE classes interviewed pride themselves as "pioneer" users among their peers (vis-a-vis non-CAE-enrolled children of the same center). They boasted about knowing how to startup/shutdown a computer or activate a particular program or game and other such knowledge. Excitement can be clearly discerned in the following sentiment that was repeatedly expressed by children of CAE classes at different centers:

> *Let me show you how to open (startup) this computer!*

"Young children just love computers." All children interviewed mentioned that they love computer lessons. They think that computers are fun and look forward to the sessions. Some even complained repeatedly,

> *My teacher did not reward me yet because the computer is spoilt. She promised to give me more time when it is repaired.*

In one off-guard moment, a heartlander parent muses aloud to nobody in particular:

> *Our children love to use computers… .We bought one so that they can use at home.*

"Affordability is an obstacle." To the parents, concern for the development of their children is such that they would like to do everything possible for them. However, they have their own constraints—largely financial. At a CAE-equipped center, one parent sighed,

> *We are paying $50 per month for our child's school fees. We want our child to be enrolled in computer class, but we need to pay $120 instead.…We have three children. We can't afford it.*

Discussion

Multiple Symbolic Representations of IT Usage in Early Childhood Pedagogy

We find that while supporters of IT usage in early childhood pedagogy are excited about the possibilities, they also have their concerns. For the non-supporters, their main concerns are impact on teacher-children relationship and affordability of CAE courses. It is interesting to note that these non-supporters did not want to acknowledge the fact that "young children just love computers." We summarize these multiple symbolic representations in Table 1.

The Invisible Chasm

With 95 percent of kindergartens equipped with CAE, it is apparent that Moore's (1991) chasm between early adopters and early majority has long been crossed in Singapore. However, based on our comparison between the supporters and the non-supporters groups, we see an invisible chasm as depicted in Figure 1. This invisible chasm lies between the late majority and the laggards. The symbol *affordability is an obstacle* is a common concern of the supporters, non-supporters, and parents/guardians alike, and appears to be a major reason for the chasm. From a literature review of IT usage in pedagogy of other countries, it can be seen that most of the countries which have computer-based learning for preschool levels are developed countries like the United States, Canada or the United Kingdom. Therefore the general and straightforward inference is that the more economically developed a country, the more advanced it is in its IT usage. Singapore is ranked second only to the United States by the World Economic Forum in the latest ranking exercise (*Straits Times* 2003) for IT penetration and usage with 70 percent of families owning personal computers. Most Western countries view Singapore as a developed country, but Singapore proclaims herself as a developing country (*Asiaweek* 2001). In any case, Singaporeans are generally seen as affluent and enjoy high living standards, and, in theory, should thus relate to an advanced level of IT usage in early childhood pedagogy.

Table 1. Symbolic Representation of IT Usage in Childhood Pegagogy

Groups / Symbols	Supporters	Non-supporters	Children	Parents/ Guardians
Pride in being one of the pioneers	✓		✓	
Young children just love computers	✓		✓	✓
Affordability is an obstacle	✓	✓		✓
Impact on teacher-child relationship	✓	✓		
Technical support a must	✓			

However, there are no national policies or guidelines in Singapore related to such usage or curriculum at present. Even major preschool operators have no standard or uniform approaches for different centers under their charge. For the same operator, some of its centers are CAE-equipped while others are not. At the same CAE-equipped center, some children are enrolled under CAE class while others either choose to be or are being kept away from computer lessons due to various concerns as depicted in our findings above. On the other hand, CAE is being introduced as early as nursery and playgroups in some other preschool centers as the children love it and their parents/guardians can afford it. To address this digital divide, we need to take a holistic approach to develop effective IT usage in childhood pedagogy to cross this invisible chasm. Beyond just the affordability issue, such an approach should particularly take into account the concerns of non-supporters regarding the impact of such usage on the teacher-child relationship.

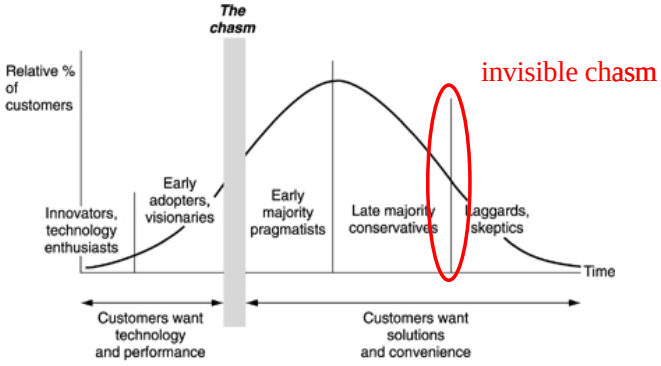


Figure 1. Moore's Chasm and the Invisible Chasm
(Adapted from Norman (1988) with permission from The MIT Press)

Implications for Research

Despite the controversy regarding IT usage in early childhood pedagogy, various policies, frameworks, and models have been developed over the years to reap the benefits and guide against the pitfalls of such usage (Government of Alberta 2004; NAEYC 1998; Van Scoter et al. 2001; Stephen and Plowman 2003). However, few deal with overcoming the barriers in integrating IT into the preschool education settings.

The RIPPLES Model

Surry's RIPPLES model (2002) and subsequent updates (Surry et al. 2003) provide a structural method of understanding the factors influencing instructional technology on higher education. Although there are significant differences and gaps between higher education and preschool education, we find that they tie in with the findings of our study. Surry's model for overcoming the barriers to integrating instructional technology centers around seven elements: **R**esources, **I**nfrastructure, **P**eople, **P**olicies, **L**earning, **E**valuation, and **S**upport. By suitably modifying the elements and introducing a new economy element, we suggest an extended model, eRIPPLES, to help in shedding light on the factors critical to crossing the invisible chasm.

Extending the RIPPLES Model

The *affordability is an obstacle* symbol in our findings pointed to the word ***e****conomy*—the community system of wealth creation. This element is perhaps most aptly justified by what is commonly know as the digital divide. In certain regions of large countries like China and India, there are vast differences between the living standard and consequently educational levels between the rural and cosmopolitan areas. In certain outlaying regions, when hunger or survival is the first and foremost problem to tackle, education (let alone CAE) seems extremely extraneous. Therefore, we need to first look at the economic status of a region, locality, or country before we can suitably apply the RIPPLES model.

The invisible chasm identified indicates that the ***e****conomy* element has a far more reaching effect than what is commonly perceived. The seven elements of the RIPPLES model all stem from a solely educational perspective. This new element should not be just seen as an addition to substantiate the factors impacting CAE-usage in educational centers; it is also a background upon which the original seven elements of RIPPLES are influenced and/or will act upon. It creates the ripples that *surround* all of the other elements. However, suitable modifications to the other elements are needed as there are significant gaps between the preschool and higher education settings. For example, under the *infrastructure* element, we observe that there are about 15 to 20 sets of computers housed in the computer room at all CAE-equipped centers visited. This is because kindergartens in Singapore have approximately 30 students per class and the ratio of 2 students to 1 computer attending CAE lessons is the most preferred. Besides addressing the affordability issue, this 2:1 rather than the ideal 1:1 ratio eliminates the possibility of overcrowding, yet

retains the social capital of enhanced learning through sharing and cooperation with a peer-partner. Unlike higher education, parents/guardians play a significant role in the development of children at this young age under the *people* element. As to the *policies* element, we found there is no single policy on IT usage that applies to all their centers for big operators. Instead, they are sorted according to locality or left to the center administrator. This is in contrast to Surry's analysis of the *policies* element on higher education regarding issues such as retention, tenure, and promotion of faculty, all of which hold little relevancy to the kindergarten setting.

The Diagrammatic Representation of the eRIPPLES Model

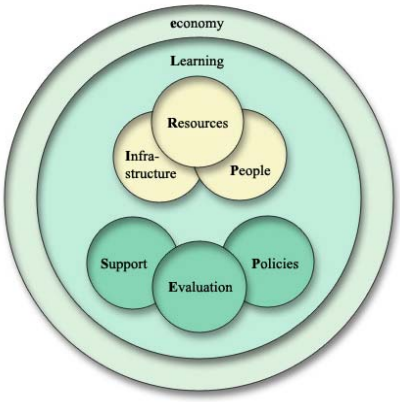
To incorporate the additional ***e****conomy* element into the original model as well as to more thoroughly demonstrate the interactions with the original seven elements in the preschool setting, an attempt was made to create a new graphical representation. We present two possible alternatives as in Figure 2.

Alternative representation 1: Resources are first only possible with an *economy* which allows for its development. It is then through adequate *resources*, that the *infrastructure* can be built and *people* can be employed to facilitate the structure. *Infrastructure* and *people* are also resources in a way, and these three elements are strongly bonded to form the core of the eRIPPLES model. *Policies* govern the way the model is developed. *People* can be motivated to contribute their best. *Support* maximizes the chance of success and *evaluation* confirms or prepares the model for change. *Learning* is the underlying aim to be achieved in this model, and is also the link which binds and gives direction as to how *policies*, *support*, and *evaluation* will evolve. These are secondary elements which together with the core elements produce the final eRIPPLES model.

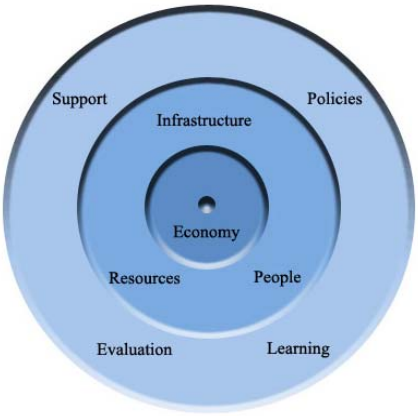
Alternative Representation 2: This representation (our preference) is developed from the idea of the traditional circular ripple effect. When an item of significant mass is dropped onto still water, a ripple is created and layers are formed and spread outward. Likewise, after the *economy* element, which is of major importance in this scenario, comes the possibility of acquiring *resources*, *infrastructure* and *people* as the core elements in the next adjacent stage (layer), and then followed by the secondary elements, *policies*, *learning*, *evaluation*, and *support* at the outermost stage (layer). This representation illustrates the importance of the arrangement and sequence in the eight elements of the eRIPPLES model. It gives due consideration to the chronological development of each element and is more consistent with the concerns of the respondents in this study.

Implications for Practice

To further address the findings in this study (particularly related to the non-supporters' concern of the potential negative impact on teacher-children relationships), we put together a **PIECES** (**P**lanning, **I**nterest of children, **E**mbedding into the curriculum, **C**ontent quality, **E**ducator's role, and **S**upport) framework for developing effective IT usage in early childhood pedagogy:



Alternative Representation 1



Alternative Representation 2

Figure 2. Possible Diagrammatic Representations of the Extended eRIPPLES Model

***P**lanning:* IT should be implemented after a planning stage, when the schools have developed clear goals for their CAE usage. The plan needs to be evaluated regularly as rapid development of IT might affect its capability to support early childhood education.

***I**nterest of Children:* To use technology effectively, practitioners must be aware of and act based on the best interests of children. Practitioners should put children's needs as their main consideration of technology usage. IT usage needs to be shaped to ensure achievement based on each child's holistic development, as defined in the kindergarten framework to include personal, social and civic skills (PSE 2003). This PSE framework is aimed to provide a guide for best practices in early childhood pedagogy. However, the framework does not provide specific guidelines for IT usage. Hence, practitioners should also take into account both current and emerging research on CAE usage in preschools.

***E**mbedding into the Curriculum:* There is a distinction between learning from, about, and with computers. Learning *about* computer involves developing expertise in various aspects of computer usage. In learning *from* computers, the computer acts as a tutor that delivers instruction to the children. Our case study reveals that both learning about and from computers have been the main focus of the CAE program. In addition, we should also focus on the children learning *with* computers instead of the computers just functioning as a standalone addition to the kindergarten curriculum. This perspective is presently lacking.

***C**ontent Quality:* A certain control method is required to provide guidance for the practitioners to choose good quality content. While general guidelines such as engaging children in creative play, mastery learning, problem solving, interaction, and collaboration (NAEYC 1998) are common, Singapore as a multiracial multicultural country requires more attention be given to cultural criteria.

***E**ducator's role:* All educators play an important role in the success and effectiveness of IT implementation in early childhood education. It is important to adapt to the shifting in their roles and to acquire the necessary knowledge to actualize effective CAE implementation. They need to establish professional judgment that good decisions are made on CAE's content and activities to ensure that benefits are achieved.

***S**upport:* As noted in our study, there is a pressing need to step up technical support, especially since it is viewed as a noncritical service at present. In addition, administrative support from top management such as the training of educators is critical in order to encourage and promote continuous improvement of the CAE educational practices.

Conclusions

In closing, this study makes several contributions. First, we employ symbolic interactionism as a theoretical lens to shed light on the perceptions of various stakeholders in the preschool environment in Singapore. Based on our findings, IT appears, on the balance, to be a suitable addition to the array of tools available for Singapore preschool children to support their quality learning and development. However, affordability and impact on the teacher-child relationship emerged clearly as major concerns of the stakeholders. In particular, we identify an invisible chasm in this Singapore context. To cross this chasm, we suggest adopting a holistic approach. In this regard, we extend Surry's RIPPLES model to the preschool setting as well as formulate a PIECES framework to guide effective usage of IT in early childhood pedagogy, both of which are grounded on empirical data and theoretical foundations. In this way, we argue that with limited resources, IT can still be used effectively and appropriately to enrich preschool learning experiences and to prepare children for the journey of life-long learning. Finally, a limitation of this study would be its weak generalizability to other settings due to its Asian (in general) and Singapore (in particular) context. Interested researchers may thus wish to explore these same concepts in other settings.

References

Asiaweek. "Don't Get Soft: In Shunning Developed Status, Singapore Keeps its Fighting Edge," *Asiaweek*, 2001 (available online at **http://www.asiaweek.com/asiaweek/96/0202/ed2.html**; accessed May 2004).

Blumer, H. *Symbolic Interactionism: Perspective and Method*, University of California Press, Berkeley, CA, 1969.

CDC. "Keynote Address by Prime Minister Goh Chok Tong at the Community Development Council (CDC) Seminar," Community Development Councils, March 19, 2000 (available online at **http://www.cdc.org.sg/data/speeches/speeches4.html**; accessed May 2004).

Charon, J. M. *Symbolic Interactionism: An Introduction, an Interpretation, an Integration* (7th ed.), Prentice-Hall, Upper Saddle River, NJ, 2001.

Crook, C. *Computers and the Collaborative Experience of Learning*, Routledge, New York, 1996.

Emerson, R. M., Fretz, R. I. and Shaw, L. L. *Writing Ethnographic Fieldnotes*, University of Chicago Press, Chicago, 1995.

Ferguson, D. "Technology in Constructivist Classroom," *Information Technology in Childhood Education Annual* (1), 2001, pp. 45-55.

FitzPatrick, P. "Reinventing Singapore: Changing a Country's Mindset by Changing Its Education System," *International Higher Education*, Spring 2003 (available online at **http://www.bc.edu/bc_org/avp/soe/cihe/newsletter/News31/text012.htm**; accessed May, 2004).

Government of Alberta. "Kindergarten to Grade 12: Technology in Schools," Government of Alberta, Canada, 2004 (available online at **http://ednet.edc.gov.ab.ca/technology/techinschools.asp**; accessed May, 2004).

Haugland, S. W. "The Effect of Computer Software on Preschool Children's Developmental Gains," *Journal of Computing in Childhood Education* (3:1), 1992, pp. 15-30.

Healy, J. M. *Failure to Connect: How Computers Affect Our Children's Minds—For Better and Worse*, Simon & Schuster, Inc., New York, 1998.

Hirschheim, R., and Newman, M. "Symbolism and Information System Development: Myth, Metaphor and Magic," *Information Systems Research* (2:1), March 1991, pp. 29-62.

Koh, P. "Let Children Enjoy Early Years Without IT," *The Straits Times*, Singapore, March 20, 1999, p. 58.

Mead, G. H. *Mind, Self and Society*, The University of Chicago Press, Chicago, 1934.

MOE. "IT in Education," Ministry of Education, Singapore, 1997 (available online **http://www1.moe.edu.sg/iteducation/masterplan/summary0.htm**; accessed May 2004).

Moore, G. A. "Crossing the Chasm," *HarperBusiness*, 1991.

NAEYC. "Technology and Young Children—Ages 3 through 8," Position Statement, National Association for the Education of Young Children, 1996, updated February, 1998 (available online at **http://www.naeyc.org/resources/position_statements/pstech98.htm**; accessed May 2004).

Norman, D. A. *The Invisible Computer*, The MIT Press, Cambridge, MA, 1988.

Prasad, P. "Symbolic Processes in the Implementation of Technological Change: A Symbolic Interactionist Study of Work Computerization," *Academy of Management Journal* (36:6), 1993, pp. 1400-1429.

Prus, R. C. *Symbolic Interaction and Ethnographic Research*, State University of New York Press, Albany, NY, 1996.

PSE. "A Framework for a Kindergarten Curriculum in Singapore," Preschool Education Unit, Ministry of Education, Singapore, 2003 (available online at **http://www.moe.gov.sg/preschooleducation/curriculum_framework.htm**, accessed May 2004).

Realworld. "Computer's Role in Education," *Realworld*, 2004 (available online at **http://www.realworld.org/**, accessed May 2004).

Ringstaff, C., and Kelley, L. "The Learning Return on Our Educational Technology Investment: A Review of Findings from Research," WestEd Regional Technology in Education Consortium of the Southwest, 2002 (available online at **http://rtecexchange.edgateway.net/learningreturn.pdf**; accessed May 2004).

Rogers, E. M. *Diffusion of Innovations* (4th ed.), The Free Press, New York, 1995.

Roschelle, J. M., Pea, R. D., Hoadley, C. M., Gordin, D. N., and Means, B. M. "Changing How and What Children Learn in School with Computer-Based Technologies," *The Future of Children Journal: Children and Computer Technology* (10:2), Fall/Winter 2000, pp. 76-101.

Seltz, J. "Some Educators Qquestion Value of School Computers," *The Boston Globe*, May 9, 1999, p. F5.

Straits Times. "S'pore is No. 2 in World IT-Savvy Rankings; It Is Second Only to the US in Study of 102 Nations Looking at IT Use by People, Business and Government," *The Straits Times*, Technology and Science Section, December 10, 2003.

Stephen, C., and Plowman, L "Using Research to Inform Policy: ICT and Preschool Education in Scotland," *Learning and Teaching Scotland*, 2003 (contact **lydia.plowman@stir.ac.uk** for an electronic copy).

Surry, D. W. "A Model for Integrating Instructional Technology into Higher Education," paper presented at the annual general meeting of the American Educational Research Association, New Orleans, LA, April 2002.

Surry, D. W., Ensminger, D. C., and Jones, M. "A Model for Integrating Instructional Technology into Higher Education," unpublished paper, University of South Alabama, 2003 (available online at **http://iphase.org/papers/RIPPLES.rtf**; accessed May, 2004).

Van Scoter, J., Ellis, D., and Railsback, J. "Technology in Early Childhood Education: Finding the Balance," Northwest Regional Educational Laboratory June 2001 (available online at **http://www.nwrel.org/request/june01**; accessed May 2004).

Vygotsky, L. *Mind in Society: The Development of Higher Psychological Processes*, Harvard University Press, Cambridge, MA, 1978.

Werner, O., and Schoepfle, G. M. *Systematic Fieldwork: Vol. 1. Foundations of Ethnography and Interviewing*, Sage Publications, Newbury Park, CA, , 1987.

Appendix A. Selected Sample of Questions Used During Site Visits

1 What are your views regarding the use of IT in early childhood pedagogy? What about for entertainment purposes (like fun, games, or sheer enjoyment)? Why? Is IT employed in kindergarten education (practical/necessary), (more harm than good but still necessary/more harm than good hence should not have)?

2. Do you think it is important for children to engage in the use of IT after preschool education? What is the right age to start?

3. Who are the main stakeholders that will make a difference to the use of IT if it were to be employed in kindergartens?

4. In the usage of IT for preschool instruction, are there barriers to adoption? What are the factors that would facilitate adoption?

5. What are some of the skills you believe can be developed by the children through using computers? What are those skills you feel computers and IT can never replace in human teaching? Do you think that a computer will ever be able to replace a human teacher?

6. Should the government make it compulsory for all kindergartens to employ/not employ IT for pedagogy purposes? If the government were to impose or strongly encourage IT to be used in childhood pedagogy, what form(s) of media and technology do you feel are more effective and why?

7. In Singapore, which stage do you think we are in, when it comes to employing IT for preschool education? How many years do you think it might take to go on to the next stage?

8. Comparing amount of total investment (in time, money, effort, and other resources) to be spent on acquiring an IT teaching system for preschoolers, against the value that might be added to their education, do you think it is worthwhile?

9. Are there any obvious moral, ethical, or social issues to be noted? If so, what are they?