Dan LI, Jian WANG

Relationship between Computer-Based Reading Activities and Reading Achievements among Hong Kong and U.S. Students: A Comparative Study Using PIRLS 2011 Data

Abstract Reading for personal interest and acquiring and using information using various reading processes are important parts of reading literacy that students need to develop in order to progress successfully through their schooling and fully function in the information society. Computer assisted reading instructional activities are assumed useful in improving the reading literacy of students, especially reading processes. However, students in Hong Kong and the US demonstrated a substantial performance gap in reading proficiency. Using the data from Progress in International Reading Literacy (PIRLS) 2011, this study examines whether and to what extent four computer-based reading instructional activities influence students' performance in reading processes central to reading for interest and acquiring and using information in Hong Kong and the US. It found that computer-based reading activities are associated with students' literacy performance in different ways in the two places. In particular, the more often Hong Kong students used the computer to read, the lower the reading achievement in all reading processes measured. However, in the US context, using the computer to write is positively associated with students' reading scores in all reading processes while using software is negatively related to their reading performance in using all the reading processes.

Keywords reading achievement, computer-based reading activities, comparative study

Dan LI (✉)

School of Education, Iowa State University, Ames, IA 50010, USA

E-mail: danl@iastate.edu

Jian WANG

College of Education, Texas Tech University, Lubbock, TX 79409, USA

Introduction

This study examines the relationship between computer-based reading activities and students' performance in reading purposes and processes as shaped by the social, cultural, and school contexts in Hong Kong and the US. This examination is situated in the following understandings about the importance of reading and the assumed influences of computer-based reading instruction and contextual factors on the development of students reading competencies.

Reading as traditionally conceived as part of literacy is a process of constructing an integrated and coherent mental representation of text that helps one understand the meanings of text elements, such as words, phrases, and their relationship (Kintsch & van Dijk, 1978). Not only does reading allow one to immerse oneself in the fictional events, characters, settings, associated feelings, emotions and ideas, and connect them to their personal experiences, feelings, and ideas to illuminate real life (Zunshine, 2006), but it also helps one acquire and use information necessary to live in the real world (Alexander & The Disciplined Reading and Learning Research Laboratory, 2012). A well-developed reading literacy is crucial for one to develop intellectually and grow personally, and a literate population is important for a nation to pursue its social, political, and economic goals (Anderson, 1985).

Reading involves a variety of complex cognitive processes. These include retrieving ideas and information explicitly stated and relating them to readers' prior knowledge or facts in earlier texts (Daneman & Carpenter, 1980), making inferences about relationships between various text elements (Garnham & Oakhill, 1996; Kintsch, 2004; van den Broek, 1994), integrating ideas and information in the text to discern overall themes (Bransford & Franks, 1971), predicting events likely to occur, evaluating unexpected consequences, judging the accuracy of information, and determining the intention and perspective implied or embedded in the text (Snow, Burns, & Griffin, 1998). In the information rich and internet technology versed world, these reading processes are especially important since technologies have affected the nature of text and the interaction between people and text (Cope & Kalantzis, 2000). For example, people are bombarded with infinitive sources of information and pushed to process multiple texts at the same time, and required to evaluate and use different sources of information constantly (Walraven, Brand-Gruwel, & Boshuizen, 2009).

However, students in different parts of the world demonstrate different levels and qualities of reading achievements that involve reading for the purposes of experiencing and acquiring information using complex reading processes (Baer, Baldi, Ayotte, & Green, 2007; Cromley, 2009; Fleischman, Hopstock, Pelczar, & Shelley, 2010; Mullis, Martin, Kennedy, & Foy, 2007; Thompson et al., 2012). In international assessments focusing on reading for the purposes of experiencing and acquiring information involving various reading processes, students in Hong Kong were not only consistently among the top performers but also left U.S. students who were also among the top performing group behind by a statistically significant distance (Mullis et al., 2007; Mullis, Martin, Foy, & Drucker, 2011).

This phenomenon fuels two popular interpretations. One is that the different qualities of reading instruction and students' reading experiences at classroom level help explain reading performance differences (Leinhardt, Zigmond, & Cooley, 1981), although in the literature other contextual factors are also seen influential (Wang, Haertel, & Walberg, 1994). These contextual factors can be but are not limited to: (1) a country's language characteristics, literacy history, and values (Rauh et al., 2003); (2) its economy and available resources (Elley, 1992); (3) school environment, climate, and curriculum (Lee & Shute, 2010); (4) parental social and economic status (Molfese, Modglin, & Molfese, 2003), literacy behaviors and attitudes (Baker & Scher, 2002), and involvement (Hewison & Tizard, 1980); (5) teachers' expertise (Taylor, Pearson, Peterson, & Rodriguez, 2003), training (Yoon et al., 2007), and attitudes (Crano & Mellon, 1978).

The assumption underlying this interpretation is that the reading instruction and students' reading experiences at classroom level play a central role in shaping students' reading performances while the influences of contextual factors as identified in the above will occur only through reading instruction and students' reading experiences at the classroom level as suggested in the literature (Kennedy, 2010; Hiebert & Morris, 2012). Although sensible, this assumption deserves a careful examination since contextual factors can also define the directions, boundaries, and scope of the influences that reading instruction and students' reading experiences at classroom level can possibly exert on students' reading performances. For example, the nature of the Chinese language as logographic characters based on meaning instead of alphabetic symbols makes reading instruction that focuses on phonological awareness less effective in the

Chinese cultural context than it is in the US, where language is alphabetic and based on phonology (Tan, 2005; Meng et al., 2011; Perfetti, Liu, & Tan, 2005).

The development of information and communications technology (ICT) over the years is transforming the reading skills that one needs to survive, live, and work in the emerging digital society and reading instruction at the same time (Kamil & Lane, 1998). It diversifies the traditional printed texts with electronic, digital, and interactive texts that change one's comprehension and ways of using writing to communicate with each other (Leu, Kinzer, Coiro, & Cammack, 2004). As a result, it is presumably expanding the traditional goal of reading instruction to include new reading skills necessary to meet the increased reading needs of emerging new texts (Leu et al., 2004). These skills are built upon traditional reading including the identification of important questions, locating, evaluating, and synthesizing information to answer those questions, and then communicating the answers to others effectively and efficiently by using the internet and ICTs (Leu et al., 2004). In addition, ICT is also changing the environment, delivery, and approaches to reading instruction to improve students' reading experiences integrated with new and old reading skills (International Reading Association, 2009).

Consequently, both the Hong Kong and US governments developed policy initiatives and devoted funding to meeting the above perceived reading needs and reading instruction shaped by ICT development (Leu & Kinzer, 2000). The governments in different parts of the world also invested to equip classrooms with internet access and ICT (2000) while international professional organizations also advocated that teachers should prepare students for their future by integrating technology into the curriculum, exploring computer based strategies and resources in their teaching of reading, and integrating ICT in reading instruction (International Reading Association, 2009).

In Hong Kong, policy makers specified a systematic approach to integrating ICT into teaching and learning by encouraging teachers to use the "Right Technology at the Right Time for the Right Task" to improve student learning including reading (Education Bureau, 2007). Digital textbooks are also used to complement traditional materials to offer a more individualized and interactive learning experience (Bakia, Murphy, Anderson, & Trinidad, 2011). In the US, governments at various levels work with businesses to improve children's literacy performance including reading by equipping schools with ICTs. As a

result, about 97% of the classrooms in public school have been equipped with at least one computer and 69% of teachers reported using or having their students use computers during instructional time (Gray, Thomas, & Lewis, 2010).

Nevertheless, policy developments in the two places leave us two unresolved issues. First, the assumed effects of using ICT in reading instruction on students' reading for the purpose of developing personal experiences and acquiring information using important reading processes is still an issue deserving cautious verification. Second, the possible influences of different social, cultural, and school contexts in different places on computer-based reading instruction and thus on student reading performance is another issue worth careful examination.

This study is designed to examine these issues. In particular, it examines the following questions directly relevant to the above issue: (1) What is the relationship between computer-based reading instructional activities and students' reading performance in retrieving and making inferences in Hong Kong and in the US? (2) If such a relationship exists, whether and to what extent are such relationships different from each other in Hong Kong and the US? (3) What are the relationships between computer-based reading instructional activities and students' reading performance in integrating and evaluating information in the two places? (4) If the relationships exist, whether and to what extent are such relationships different in Hong Kong and the US?

Literature Bases

Conceptual Framework

Two theoretical assumptions frame the focus and examination of this study. The first is the assumption about new literacy skills including reading and the role of the internet and ICT-based instruction in the development of these skills that Leu and his colleagues propose (2004). Following this assumption, what counts as a competent reader is undergoing tremendous transformation in the emerging internet and ICT world.

One of the obvious transformations is the proliferation of electronic, digital, and interactive texts and substantial reduction in the use of traditional printed texts, changing one's comprehension and ways of using writing to communicate with each other (Leu & Kinzer, 2000). Such a transformation is making some traditional reading purposes and processes ever more crucial for one's life and

work in the emerging digital society (Leu et al., 2004). For example, using the computer to identify important questions, locate, compare, interpret, evaluate, and synthesize information to answer those questions, and then communicating the answers to others effectively and efficiently in the internet and ICT environment (Leu et al., 2004). Consequently, the use of the internet and ICT to help student develop reading comprehension is no longer a supplement to the traditional reading instruction but part of reading competence that the teacher needs to support students to acquire.

Moreover, it also changes meaning making in reading from simply relying on traditional writing representation confined to printed text to integrated multiple literary representations including textual, oral, visual, tactile, gestural, and spatial representation (Kalantzis, Cope, & Cloonan, 2010). Such integrated multiple literary representations are assumed to allow children to use their natural synthetic capacities that will help enhance profoundly their meaning making in reading (Leu et al., 2004). Consequently, the integrated multiple literary representations offer a great potential to transform the environment, delivery, and approaches of traditional reading instruction and improve its effectiveness (Leu et al., 2004).

However, whether and to what extent the use of computer-based reading activities will help students develop important reading processes central to their new reading competences in the internet and ICT world is still a question that has yet to be empirically examined as we point out later in the empirical literature review section. This study was developed to examine this assumption.

Another theoretical assumption that frames this focus and the design of the study is the idea of culturally responsive teaching, which suggests that learning is only meaningful and thorough when students' unique cultural characteristics, experiences, and perspectives are respected and considered (Gay, 2002). Therefore, teaching approaches effective for students from one ethnic group may not be effective for other ethnic group (Ladson-Billings, 1995). In the field of literacy education, culturally responsive pedagogies, such as integrated multiethnic literature in reading and writing, connecting home, community and school literacy practices, have been developed to address the needs of literacy development of various cultural and ethnic groups of students (Callins, 2006; Alvermann, 2002).

One of the theoretical ramifications based on this culturally responsive teaching

theory relevant to the focus of this study is the assumption that the Chinese language acquires the logograph characteristic based on meaning which is different from English which is alphabetic and phonological (McBride-Chang & Kail, 2002). Such a language characteristic is assumed to make the reading instructional approaches that focuses on the development of students' phonological awareness ineffective for Chinese students (McBride-Chang & Kail, 2002). Following this assumption, engaging students in writing can help mediate Chinese students' reading development (Tan et al., 2005). However, the use of the computer, which heavily relies on *pinyin* for input, will hurt Chinese students' reading development since *pinyin* is an alphabetic system that helps Chinese students to pronounce Chinese characters by associating phonemes with Chinese characters (Tan, Xu, Chang, & Siok, 2013). This study has also been designed to examine some of these assumptions indirectly.

Empirical Literature Review

To situate this study in the current literature regarding the relationship between computer-based reading activities and reading achievement, key words such as *reading comprehension*, *computer-based*, *reading instruction*, *new literacy*, *reading achievement*, *retrieving*, *making inferences*, *integrating*, and *evaluating information* were used to search relevant literature in the databases including Education Resources Information Center (ERIC), Academic Search Premier and PsycINFO. Google Scholar was also used to search for the articles that are not included in these databases. The body of literature emerging from the above searches was then screened based on whether the articles were published between 1995 and the present when internet and ICT were greatly developed, and whether the effects of computer-based reading instruction on reading comprehension, reading processes and reading achievement were examined.

These screening processes led to one study directly examining the relationship between computer-based reading activities and reading processes relevant to the new literacy. In the study, Sung, Chang, and Huang (2008) examined the effect of computer-based reading instruction on students' use of five reading strategies: self-questioning, error detection, making inferences, summarization, and integration. They found that students exposed to computer-based reading instruction outperformed the students exposed to traditional reading instruction. However, the study was not conducted in a cross-national environment, had a

relatively small sample of 130 sixth graders and paid little attention to various kinds of computer-based reading activities.

Other relevant studies identified from our screening processes have also contributed to the understanding of the research questions in several ways, despite not being focused on different computer-based reading activities. First, two review studies showed that the use of computer-based activities affected students' reading comprehension. In a meta-analysis literature review of 20 research articles related to the use of digital tools and reading acquisition, Pearson, Ferdig, Blomeyer Jr., and Moran (2005) found an overall positive effect of computer-based reading instruction on reading comprehension. In another review study based on 33 articles on the effect of four types of programs to improve reading achievement, Slavin, Cheung, Groff and Lake (2008) found that the effect of computer-based instruction on students' reading achievements was also positive but small.

However, in both reviews, computer-based reading instruction was treated as a unified factor and the outcome as reading achievement without any attention given to the differentiation between various computer-based reading activities and reading processes. Another limitation of these reviews is that none of them intended to capture the relationship between computer-based reading activities and reading processes internationally. This study examines the relationships between computer-based reading activities and students' reading achievements by discriminating between computer-based reading activities as different influencing factors and the reading processes as various outcomes in Hong Kong and the US.

Second, another two studies demonstrated that computer-based reading instruction affected students' decoding and phonological awareness which is important for reading. In an experimental study, Macaruso and Walker (2008) grouped 94 kindergarteners into those exposed to a computer program that offers systematic exercises in phonological awareness and letter-sound correspondences and those having traditional reading instruction. They found that children in the treatment group outperformed their peers in the control group in decoding skills and phonological awareness. This finding is confirmed in a similar experimental study (Chambers et al., 2008) using 159 first graders as participants.

Obviously, both studies failed to examine the direct relationship between computer-based reading activities and the reading processes central to new

literacy in cross-national contexts. The current study addresses the limitation of these studies by directly examining the relationship between computer-based reading instruction and some specific reading processes central to reading in cross-national contexts.

Finally, two more studies compared computer-based reading with print-based reading for their effects on student reading achievements. For example, Wästlund, Reinikka, Norland, and Archer (2005) compared students' reading comprehension performance on the computer and in print-based reading by assigning 72 college students either to a paper-presentation group or to a video display terminal group. They found that the students performed better in the print-based environment than in the computer-based environment because the use of the computer to read might result in students' higher cognitive workload. Mangen, Walgermo and Brønnick (2013) came to the same conclusion in a similar study using test material from the Program for International Student Assessment (PISA).

These two studies together pose a challenge to assumptions about computer-based reading as necessary and useful for improving students' new literacy. The current study extends this line of research by examining the relationships between four different computer-based reading activities and the reading processes cross-nationally.

Research Methods

Data Source and Sample

The data of this study came from a large-scale study, Progress in International Reading Literacy Study 2011 (PIRLS 2011) that provides information about the reading performance of students at fourth grade level in different places including Hong Kong and the US. Several considerations led us to choose the data from PIRLS 2011 for this study.

First, the reading competences assessed in PIRLS 2011 included reading for the purposes of developing personal experiences, and acquiring and using information that involves retrieving information, making direct inferences, interpreting, integrating and evaluating information reading processes (Mullis et al., 2009). These reading competencies are consistent with the reading

competences central for one to survive, live, and work in the information-rich and technologically-based world (Leu et al., 2004) that this study intended to examine.

Second, in PIRLS 2011, how teachers use various computer-based reading instructional activities was also surveyed among teachers in both Hong Kong and the US, including the use of the computer in teaching students to search for information, read stories, write, and develop reading skills (Mullis et al., 2009). These computer-based reading activities are consistent with those ICT reading instructions central to the development of one's new literacy (Henry, 2006; Schmar-Dobler, 2003) that is also the focus of this study.

Finally, in PIRLS, there is a mathematical formula to estimate the appropriate sample size to reach sampling precision for each participating country/region including designating the target schools, teachers, and students that can represent the nation (Martin, Mullis, & Kennedy, 2007). The actual sample in this study includes 1,645 fourth graders and 63 teachers who taught these students from Hong Kong and 7,298 US fourth graders and 386 teachers who taught these students.

Variable Construction

The dependent variables of this study are Hong Kong and U.S. students' reading achievement scores in "retrieving and straightforward inferencing" and "interpreting, integrating, and evaluating" as measured by PIRLS 2011 using multiple choices and constructed-response items (Mullis et al., 2011). In PIRLS 2011, the combined scores of reading achievements can be separated into scores of students' reading performance in retrieving and making direct inference and those in interpreting, integrating, and evaluating information separately (Foy & Drucker, 2013). Thus, these scores for each place are used as the dependent variables for this study.

The independent variables are four kinds of computer-based reading activities that Hong Kong and U.S. teachers use in their reading teaching practices, constructed based on the following questionnaire items with the teachers in the two places (Mullis et al., 2009). These items asked the teachers to rate the frequencies that they had their students use computers to (1) search information (info), (2) read text (stories), (3) write (write), and (4) use software to develop reading skills and strategies (software) at four scale levels. These scales were "1

= every day or almost every day,” “2 = once or twice a week,” “3 = once or twice a month,” and “4 = never or almost never use.” These items were first recoded with smaller value referring to less frequent use of the activity and greater value referring to more frequent use the activity. The recoded items were used as predictors for reading performances in retrieving, making direct inference, interpreting, integrating, and evaluating reading processes.

Two control variables, student gender and socioeconomic status (SES), were used in the analysis. Student gender was used as a control variable because in the existing literature, female students were often found to have better reading performances than male students (Hyde & Linn, 1988). Thus, gender was thought to possibly confound the effects of the independent variables, different computer-based reading activities, on students’ reading achievement in the study and thus, needed to be controlled.

The reason for using students’ SES as a control variable is that in the existing literature, students with lower SES tend to have less home reading experience, have fewer books at home, and fewer opportunities to receive tutoring (Evans, 2004; Astone & McLanahan, 1991; Chiu & Khoo, 2005; Entwisle & Alexander, 1995). Thus, they are found to have much lower performance than those from families of higher SES (Lee, Griggs, & Donahue, 2007). In this study, SES is reflected by a composite score of items possessed by the student’s household as determined by the survey answers, and included the five common items of computer, study desk, personal books, personal room, internet connection as well as several country-specified items in both places. For students in Hong Kong, the country specified items asked if the student took orchestral instrument lessons, if there was a domestic helper, car, and private tutor at home, if the student traveled by plane with parents at least twice last year, and if the student went to an art center with his or her parents last year. For students in the US, country specified items asked were if the student had an encyclopedia, video game system, VCR or Blue-ray player at home. These items were “yes” or “no” questions. All the items were added to get a total SES score, with higher score indicating higher SES.

Data Analysis

Taking into account the nested structure of PIRLS 2011 data, meaning that students are nested in classes and classes are nested in schools, multilevel modeling is used to analyze the effect of teachers’ using four computer-based

reading activities on students' reading performance in retrieving, making direct inference, interpreting, integrating, and evaluating information (Raudenbush & Bryk, 2002). The data in Hong Kong and the US were analyzed through four models respectively according to the convention of multilevel modeling as suggested for this situation (Raudenbush & Bryk, 2002).

An unconditional model (null model) was formulated without predictors first to see if there is significant clustering teacher effect in this study, namely if the students taught by different teachers were significantly different from each other in their reading scores. The null model is as follows:

$$\begin{aligned}\text{Reading achievement} &= \beta_{0j} + r_{ij} && \text{Level 1} \\ \beta_{0j} &= \gamma_{00} + u_{0j} && \text{Level 2}\end{aligned}$$

In this model, at level one, we express students' reading achievement as the sum of the average reading achievement of students taught by same teacher (β_{0j}) and a random error (r_{ij}) associated with i th student taught by the j th teacher. At level two, we express the teacher level intercepts as the sum of an overall mean (γ_{00}) and a series of random deviations from the mean (u_{0j}).

Then, the conditional Hierarchical Linear Modeling (HLM) is used to extend the null model by adding the control variables, namely gender and SES. This HLM shown below as Model 1 is used to examine the effect of gender and SES on students' reading achievement.

$$\begin{aligned}\text{Reading Achievement} &= \beta_{0j} + \beta_{1j}*(GENDER_{ij}) + \beta_{2j}*(SES_{ij}) + r_{ij} \\ \beta_{0j} &= \gamma_{00} + u_{0j} \\ \beta_{1j} &= \gamma_{10} \\ \beta_{2j} &= \gamma_{20} && \text{Model 1}\end{aligned}$$

In this model, students' reading achievement is expressed as the sum of the average reading achievement of students taught by same teacher (β_{0j}), the effect of gender (β_{1j}), the effect of SES (β_{2j}) and a random error (r_{ij}) associated with i th student taught by the j th teacher.

Next, Model 2 was used by extending Model 1 in the above. In this model shown below, the independent variables at teacher level, four computer-based reading activities, are added to see if any of them can predict students' reading achievements with any degree of significance (1) "retrieving and straightforward inferencing" and (2) "interpreting, integrating, and evaluating" after controlling gender and SES in Hong Kong and the US.

$$\text{Reading Achievements} = \beta_{0j} + \beta_{1j}*(GENDER_{ij}) + \beta_{2j}*(SES_{ij}) + r_{ij}$$

$$\beta_{0j} = \gamma_{00} + \gamma_{01}*(INFO_j) + \gamma_{02}*(STORIES_j) + \gamma_{03}*(SOFTWARE_j) + \gamma_{04}*(WRITE_j) + u_{0j}$$
$$\beta_{1j} = \gamma_{10}$$
$$\beta_{2j} = \gamma_{20}$$

Model 2

The meaning of the model at level 1 is the same as that in the previous model. At level two, we express the intercept of reading achievement as the sum of the overall mean (γ_{00}) and the effect of using the computer for looking for information (γ_{01}), using the computer to read stories (γ_{02}), using computer software (γ_{03}) to develop reading skills, using the computer to write (γ_{04}), and the associated random error (u_{0j}).

Limitation

This study has two obvious limitations. First, it relied on a survey of teachers to gather the data about their computer-based reading teaching practice without actual observation, which prevented us from identifying those characteristics of computer-based reading instruction used in the classrooms but not surveyed. Second, only limited items were used in the study to measure the frequencies of their use, which may not capture how teachers conduct these activities in their classroom, something that might help identify the quality of their teaching.

Results

Our subsequent analyses in the study led us to several results relevant to the research questions posed in this study. First, it was found that students taught by different teachers are significantly different from each other in their reading scores involving both retrieving and making inference as well as evaluating and integrating reading processes in Hong Kong and the US as confirmed by the null model analysis in the study.

As shown in Table 1 below, in Hong Kong, the intraclass correlation coefficient for retrieving and making direct inferences is .2712 and for interpreting, integrating, and evaluating it is .2758. These numbers means that teacher effect factors explain about 27.12% of the variance in student reading achievement in using retrieving and straightforward inferencing reading processes and 27.58% of the variance in student performance in using interpreting, integrating, and evaluating reading processes. Similarly, in the US, the intraclass correlation coefficients for directly retrieving and inferring from

information and for interpreting, integrating, and evaluating information are .1194 and .3032 respectively. These numbers indicate that teacher related effects explain 11.94% of the variance in student reading performance in retrieving and straight forward inferencing and 30.32% of the variance in student reading achievement in interpreting, integrating, and evaluating.

Table 1 Between Group and within Group Variance

	Hong Kong		The US	
	Read to retrieve & infer	Read to interpret, integrate, and evaluate	Read to retrieve and infer	Read to interpret, integrate, and evaluate
Between group	1,063.4	760	1,605.2	1,545.1
Within group	2,792.3	3,051.5	3,689	4,152.2
ICC	.2712	.2758	.1194	.3032

Second, different computer-based reading activities exerted very different influences on students’ reading achievements in retrieving and inferring directly from information in the two places. The more often the teachers in Hong Kong asked their students to use the computer to read, the lower reading achievements their students had in retrieving and inferring directly from information. Comparatively, the more often the US teachers had their students use computer software to develop reading skills, the lower the reading performance their students achieved while the more often the US teachers asked students to write, the higher they achieved in retrieving and inferring straightforward information.

As shown in Table 2 below, in Hong Kong, after controlling for gender and SES, having students use the computer to read stories significantly and negatively predicted students’ performance in retrieving and making inferences, as $\beta = -9.25$, S.E. = 3.91. The other three computer-based reading activities were not significant predictors of students’ performance in retrieving and making inferences. Conversely, when gender and SES were controlled, US teachers’ using computer software to develop reading strategies and skills significantly and negatively predicted students’ performance in retrieving and making inferences, as $\beta = -9.64$, S.E. = 2.08 while their using the computer to write significantly and positively predicted students’ performance in retrieving and making inferences, as $\beta = 7.68$, S.E. = 2.69. The other two computer-based reading activities failed

to predict with significance US students’ performance in retrieving and making inferences.

Table 2 Parameter Estimates of Reading Achievement in Retrieving and Making Direct Inferences

Variable	Hong Kong		The US	
	Coefficient	S.E.	Coefficient	S.E.
SEX	−9.59*	3.65	−7.95*	1.52
SES	−2.73*	.86	7.11*	.81
Info	3.22	6.31	2.73	3
Stories	−9.25*	3.91	.43	2.65
Write	2.8	6.44	7.68*	2.69
Software	1.65	4.03	−9.64*	2.08

Note. * $p < .05$

Third, different computer-based reading activities also had very different influences on students’ reading achievements in using interpreting, integrating, and evaluating reading processes in the two places. The more often the teachers in Hong Kong had their students use the computer to read, the lower reading achievements their students had in interpreting, integrating, and evaluating information. In contrast, the more often US teachers had their students use computer software to develop reading skills, the lower the reading achievements their students had in interpreting, integrating, and evaluating information while the more often the US teachers had students to write, the higher the students could achieve in interpreting, integrating, and evaluating information.

As shown in Table 3 below, in Hong Kong, after controlling SES and gender, using the computer to read stories significantly and negatively predicted students’ performance in interpreting, integrating and evaluating information, as $\beta = -9.86$, S.E. = 4.4. The other three computer-based reading activities were not significant predictors of their students’ reading achievement in using these reading processes. In the US, after controlling for gender and SES, teachers’ use of computer software to develop reading skills and strategies predicted significantly but negatively students’ performance in interpreting, integrating and evaluating information, $\beta = -10.06$, S.E. = 2.09. However, teachers’ use of the computer for writing tasks predicted significantly but positively students’ performance in interpreting, integrating and evaluating information, $\beta = 8.35$, S.E. = 2.69. The

other two computer-based reading activities were not significant predictors of students’ reading achievement in interpreting, integrating and evaluating information.

Table 3 Parameter Estimates for Reading Achievement in Interpreting, Integrating and Evaluating

Variable	Hong Kong		The US	
	Coefficient	S.E.	Coefficient	S.E.
SEX	−14.12*	3.59	−9.85*	2.03
SES	−2.33*	.94	7.27*	.74
Cinfo	4.04	7.27	2.63	3.02
Cstories	−9.86*	4.4	.26	2.69
Csoftware	1.71	4.51	−10.06*	2.09
Cwrite	3.65	7.19	8.35*	2.69

Note. * $p < .05$

Fourth, students’ SES predicted students’ reading achievements differently in the two places. In Hong Kong, the lower family SES students had, the higher their reading performance both in using retrieving and making direct inferences, and in interpreting, integrating, and evaluating reading processes. However, opposite trends can be found in the US context in which for students of lower SES, their reading achievements are lower both in retrieving and making direct inferences and in interpreting, integrating, and evaluating information.

As shown in Tables 2 and 3, in Hong Kong, after controlling for computer-based reading activities and gender, students’ SES predicted significantly but negatively their reading achievements in retrieving and making direct inferences, $\beta = -2.73$, S.E. = .86 and in interpreting, integrating, and evaluating, $\beta = -2.33$, S.E. = .94. In the US, students’ SES had predicted significantly and positively their reading achievements both in retrieving and straightforward inferences, $\beta = 7.11$, S.E. = .81 and in interpreting, integrating and evaluating information, $\beta = 7.27$, S.E. = .74.

Finally, in both places, female students had better reading achievements than their male peers in using all the reading processes. Both Tables 2 and 3 indicate that in Hong Kong, after controlling for all computer-based reading activities and SES, the difference between boys and girls was statistically significant in retrieving and making direct inferences as $\beta = -9.59$, S.E. = 3.65 and in

interpreting, integrating, and evaluating, $\beta = -14.12$, S.E. = 3.59. Similarly, in the US, after controlling for all computer-based reading activities and SES, boys' reading achievements in retrieving and making direct inferences and in interpreting, integrating, and evaluating information were significantly different from girls as $\beta = -7.95$, S.E. = 1.52 and $\beta = -9.85$, S.E. = 2.03 respectively.

Discussion and Conclusions

This study, in spite of the limitations mentioned earlier, has helped us understand each of our research questions in the following ways. First, although teachers were found to play an important role in shaping students' reading performance in using all the measured reading processes in the both places, the study shows that teachers who asked students to use the computer to look for information frequently failed to influence their students' reading achievement in using all the reading processes in Hong Kong and the US. As shown in the study, no matter if teachers had students use the computer to acquire information or not, their students' reading scores in the two kinds of reading processes did not change in a statistically significant way in the two places.

This finding, to an extent, is consistent with Henry's (2006) argument that simply seeking information on the internet may not guarantee that readers have a more sophisticated use of locating, evaluating, integrating, and making inferences. It also supports indirectly the assumption that searching for information increases the cognitive load since readers' frequent accesses to many hyperlinks require them to make decisions that could impair their reading comprehension (Choi & Tinkler, 2002, April; DeStefano & Lefevre, 2007).

Second, the study also suggests that the computer-based reading instructional activities that helped or did not help students develop important reading processes in one place may not have the same effects in the other. As demonstrated in the results section, by asking students to use the computer to write, the US teachers exerted a positive influence on their students' reading achievements in all measured reading processes, but this failed to exert the same influence in the Hong Kong context. In contrast, by having students use the computer to read stories, Hong Kong teachers had a negative influence on their students' reading achievement in all the measured reading processes, which was not the case in the US context. The same is true with the negative influence in the

US context on student reading achievements in which teachers have students use software to develop reading skills, which was not observed in the case of Hong Kong.

Nevertheless, the finding that using the computer to write positively predicted US students' reading achievements in using all the measured reading processes can be explained by the facilitating role of writing on reading comprehension since writing fosters explicitness, information integration, reflection, personal involvement with text and transforming or manipulating language (Applebee, 1984; Klein, 1999; Stotsky, 1982). It is also consistent with the ideas that writing actually helps develop the similar mental processes and isomorphic knowledge in reading (Fitzgerald & Shanahan, 2000). However, why using the computer to write is not working in the Hong Kong context deserves a further explanation since it obviously contradicts the theory that writing may play an important role in helping Chinese students develop reading comprehension as the Chinese language has the logograph characteristics based on meaning instead of a alphabetic system based on phonemes (Tan et al., 2005).

The finding that using the computer to read stories negatively predicted Hong Kong students' reading processes seems to be hard to explain as it is against the assumption that reading for personal experience also involves complex reading processes, such as retrieving and making direct inferences as well as interpreting, integrating, and evaluating information (Van den Broek, Lorch, Linderholm, & Gustafson, 2001). Again, this only occurred in the Hong Kong context instead of the US, which is worth further examination.

In addition, the fact that using software to develop reading skills negatively predicted the US students' reading processes is inconsistent with the finding of the study that computer programs can develop comprehension skills such as making inference and integration (Sung, Chang, & Huang, 2008). However, why does this not happen in Hong Kong, which is an interesting question that requires an appropriate answer.

Together, the above results suggest that computer-based reading activities did not positively predict Hong Kong students' reading achievements in using any of the reading processes measured. This finding seems to be consistent with the assumption that the use of the computer, which heavily relies on pinyin for input can hurt Chinese students' reading development since pinyin is an alphabetic system based on associating phonemes with Chinese characters (Tan et al., 2013)

as we argued in the theoretical framework discussion. Thus, it supported indirectly the assumption following the cultural responsive teaching theory that suggests students from different social, cultural, and ethnic backgrounds often develop needs, habits, and ways of learning that are relevant to their backgrounds (Gay, 2002).

While helping identify that computer-based reading instruction activities that are effective in one place may not work in the same way in the other, the present study is unable to offer a satisfactory yet data-based explanation about why and how these discrepancies happen. To offer such an explanation, an observation and interview-based comparative study that uses a qualitative approach is surely necessary.

The implication of this finding is that the computer-based reading instructions designed to help students from different countries with varied cultural backgrounds and contexts to develop important reading processes should be different with respect to students' varied cultural backgrounds and contexts. Thus, the effectiveness of computer-based reading instruction should be carefully examined and tested with students in different contexts before being set to use as the model for shaping teaching practices in different classrooms (Sykes, Bird, & Kennedy, 2010).

Last but not least, one of the intriguing and unintended findings of this study is that students' SES has an opposite impact on students' reading achievements in retrieving and making direct inferences about information and in interpreting, integrating, and evaluating information in the two places tested.

As shown in the result section, although this study shows that the gender gap in students' reading achievements by favoring females is consistent with the existing literature (Hyde & Linn, 1988), it has failed to demonstrate a consistent finding with the existing literature. In the present study, the higher students' family SES, the higher students' reading achievements in the US context. However, for Hong Kong students, the higher the family's SES, the lower their reading achievements.

This finding regarding Hong Kong students contradicts clearly the empirical evidence from studies in the US and Hong Kong or even other East Asian nations (Bowey, 1995; Feagans & Farran, 1982; Zhou & Kim, 2006). Furthermore, it raises a challenge to the popular theoretical assumption suggesting that students with lower SES tend to have less home literacy experience, have fewer books at

home, and fewer opportunities to receive tutoring and thus, lower reading achievements (Evans, 2004; Astone & McLanahan, 1991; Chiu & Khoo, 2005; Entwisle & Alexander, 1995). Such a situation requires an appropriate interpretation.

Again, although bringing this finding to the light, the present study is not able to offer a satisfactory data-based explanation as to why and how SES exerts a contrary influence on students' reading processes against popular understanding. To offer such an explanation, further observation and an interview-based study that uses a qualitative approach is essential.

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