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Promoting Education Equity in Rural and Underdeveloped Areas: Cases on Computer-Supported Collaborative Teaching in China

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ABSTRACT

In addition to the 37 million students attending rural schools, China operates ~67,000 one-teacher schools in remote and mountainous regions. Much research has concluded that these rural students are educationally disadvantaged in comparison to their urban peers, with impaction toward social stratification. Consequently, national policies have targeted such issues and begun implementing information and communication technology (ICT) initiatives to universalize the quality of educational services. However, it is well known that imbalanced or improperly utilized ICT resources may expand, rather than contract inequities. Therefore, our research examines two cases of uniquely large-scale educational ICT applications to showcase computer-supported collaborative teaching models with high potential from an equity perspective. Improved access in the quality of students' education and teachers' professional development opportunities among rural areas are the main benefits observed. Other developing countries with similar issues may replicate these technological approaches for balancing access to high quality educational opportunities.

Keywords: information and communication technology, collaborative teaching, rural-urban disparity, open online teaching units, remote synchronous classroom

INTRODUCTION

Education equity[1] refers to fairness and justice in educational opportunity (Gillborn & Deborah, 1990). Much research has shown that inadequate educational opportunities have both negative individual and societal consequences (Buchmann & Hannum, 2001; Campos, Ren, & Petrick, 2016). Such consequences have led the United Nations' toward coordinating international remediation efforts that generate capacity for universal educational opportunity over the past 70 years (United Nations, 1941; UNESCO, 1990, 2000, 2015a). However, despite much progress, inequity within education persists. UNESCO (2015a) stated that, "policy has often been distanced from implementation" (p. 56). Therefore, the conceptualization and benchmarking of large-scale solutions that promote education equity remain in high demand throughout the world.

In China, the question of how education equity can be promoted also remains a critical issue. The initial discussion focused on inequity of circumstance between eastern and western development. However, rural disparity has more recently emerged in research as the most prominent factor driving inequity (Gan, Meng, & Xie, 2016; Golley & Kong, 2016; Hallinger & Liu, 2016; Li & Ranieri, 2013; Normile, 2017; Rao & Ye, 2016; Wang, Wang,

[1] Gillborn and Youdell (1990) further described education equity to include four aspects: (1) access, a complete lack of availability or explicit denial of education services due to some basis of identity; (2) circumstance, participation barriers in education systems due to inequalities of personal living situations; (3) treatment, typical daily interaction and processes of education systems that affect individuals differently; and (4) outcomes, the result of educational processes (pp. 2-3). This study emphasizes the circumstance aspect of education equity between rural and urban regions.

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Contribution of this paper to the literature

- Education equity is a critical global issue that is expected to be positively influenced by ICT applications; however, ICT policy is often cited as being distant from actual practice and no large-scale ICT solutions have been widely adopted as successful in balancing education equity.
- This paper reviews the extant literature of education equity in China and ICT-supported collaborative teaching approaches to add conceptual information and qualitative evaluation from an education equity perspective.
- Cases highlighting implementation of 'Open Online Teaching Units' and 'The Remote Synchronous Classroom' are presented and discussed to expedite adoption and direct future research on this topic.

Li, Li, 2017; Wu, 2013; Yang & Wan, 2015; Zhou et al., 2015), describing the issue as a more serious dilemma affecting both eastern and western regions of China.

The deployment of technology has become a key component in government mitigation efforts, because the integration of information and communication technology (ICT) can provide many benefits to education quality. For example, improving access, personalization, and flexibility for learning processes. However, when access or usage of ICT is unbalanced, as is seen among rural-urban Chinese settings (Li & Ranieri, 2013), the resulting digital divide can widen inequity in education. That is to say, appropriate ICT integration further improves the already higher standard of urban education conditions, while the inaccessible or underutilized ICT applications of rural areas may only maintain existing conditions. This notion of the digital divide has recently been highlighted as a critical issue reshaping the boundaries of universal accessibility research, which more commonly has focused on disparity issues affecting smaller fractions of people (Abascal, Barbosa, Nicolle, & Zaphiris, 2016). Therefore, in order to prevent worsening conditions of education equity, ensuring balanced access and utilization of educational resources is an issue of immediate importance. This research examines two cases of computer-supported collaborative teaching models to support governments in providing universal access to high quality educational resources.

THEORETICAL FRAMEWORK

During the period of opening up and reform, China underwent a complete expansion in access to primary and secondary education. The *National Bureau of Statistics of China* shows that near universal enrollment in primary and secondary education systems was achieved in 2006; and the corresponding 'national average years of schooling' crossed the nine-year threshold in 2013. In recognition of universal enrollment, research indicates that the current status of education equity in China is most accurately explained by the effectively maintained inequality (EQI) hypothesis (Yang & Wan, 2015), which suggests that after a society achieves universal enrollment, inequity may continue to exist within the provision of differing qualities of education (Lucas, 2001). This theoretical perspective provides a foundation for the present study when examining the education equity–circumstantial quality–between rural and urban education systems.

HISTORICAL REVIEW: EDUCATION EQUITY IN CHINA

The two primary mechanisms that affect education quality are intergenerational persistence and the provision of educational services (Golley & Kong, 2016). Intergenerational persistence describes the indirect factors that influence education quality, such as socioeconomic status and the relationship of family support for educational opportunity and attainment of their children (Hertz et al., 2007). The provision of educational services describes direct factors which influence education quality such as the human and technological resources of education systems.

Intergenerational Persistence

Much research has explored intergenerational persistence in China and supported the notion that higher levels of parents' education typically correlate with greater educational attainment by their children (Golley & Kong, 2013). This is significant given that individuals' per capita disposable income and average years of schooling are both higher in urban areas[2]. Research has also suggested that modern family structures are changing differently, according to whether the setting is rural or urban (Normile, 2017; Wang, 2010). Due to the economic pull of

[2] National Bureau of Statistics of China 2015 data shows rural-urban per capita disposable income is ~11,000 to ~31,000, respectively. Meanwhile, 2010 data shows rural-urban average years of schooling of households is 7.6 to 10.5, respectively.

Table 1. Comparison of teachers with advanced degrees [1]

	2012	2013	2014	2015
Rural	78%	81%	83%	85%
Primary	77%	80%	84%	86%
Regular junior secondary	63%	66%	69%	73%
Regular senior secondary	95%	96%	96%	97%
Suburban	84%	86%	88%	89%
Primary	87%	91%	91%	93%
Regular junior secondary	68%	72%	75%	77%
Regular senior secondary	95%	96%	96%	97%
Urban	92%	93%	94%	95%
Primary	94%	95%	96%	97%
Regular junior secondary	84%	86%	88%	89%
Regular senior secondary	98%	98%	98%	98%

[1] Primary school teacher data describes the proportion of degrees above 3 years of college; Junior and senior secondary school teacher data describes the proportion of degrees above bachelors.

Source: Authors' calculation from *Educational Statistical Yearbook of China* 2013-2016 data.

urbanization, China has experienced a complete shift of population composition and these migration trends[3] have reduced the number of nuclear families in rural areas, which in turn weakens the foundations for supporting educational success among rural students. Such factors of intergenerational persistence offer representative descriptions of rural disparity and should not be overlooked when discussing this topic. However, since intergenerational persistence is indirectly influential toward the quality of one's education, intergenerational persistence is not the primary focus of the study. Rather, the directly influential factors of educational services are the main focus of this study.

Provision of Educational Services

The access to quality educational services can typically be described by two main factors of impact: (1) *human resources*, which primarily refers to teachers and (2) *technological resources*, which primarily describes the physical and digital learning content and tools that support educational processes. To describe the status of education equity, this section reviews the human and technological resources present in Chinese education.

Human resources

Teacher and teaching quality can be assessed in several ways. The most common measures explore teachers' educational attainment, the organizational processes that shape teacher development, and the scope of teacher responsibilities which impact their teaching effectiveness. Analysis of 2016 data from the *Educational Statistics Yearbook of China,* published by the Ministry of Education of China, suggests equity of teacher quality based on the proportion of full-time teachers with advanced degrees, is less favorable among rural areas. As shown in **Table 1**, rural students are 11% less likely to have access to a teacher with an advanced degree after accounting for the number of students enrolled in each level of education. More specifically, the data show that rural junior secondary students have the weakest access to teacher quality, with only 73% of full-time teachers possessing advanced degrees.

The organizational processes of teacher training and collaboration are also important factors that influence education equity between rural and urban regions. Hallinger and Liu (2016) suggested that organizational processes of school leadership and teacher learning are important to sustaining students' performance improvement. By examining teachers in both urban and rural settings, findings identified significantly less on-the-job learning among the rural teachers, which indicated that the engagement of school-level processes may result in different patterns of growth that increase inequity overtime (Hallinger & Liu, 2016).

This notion of organizational processes being critical to instructional capacity was also examined. The results showed rural-urban inequity in relation to Teaching and Research Groups (TRG), whereby rural TRG processes were found to be less engaging and rigorous (Wang et al., 2017). Critical educational processes such as peer class observation, collective lesson planning, and novice teacher mentorship programs were found to be much less frequent among rural schools. To supplement this comparison with western research on teacher learning, research analyzed more than one million student-year observations over a ten-year time period in the USA and identified a variety of educational influences (Jackson & Bruegmann, 2009). For example, first year teachers were seen as being

[3] The National Bureau of Statistics of China shows the demographic composition of the population has shifted from ~83% rural residency in 1975 to ~44% rural residency in 2015.

detrimental to student learning, meanwhile, having a collaborative network of teachers with more than one year of teaching experience was significantly positive. Additionally, students showed greater achievement gains in mathematics and reading when their teachers were involved with colleague observations and on-the-job learning (Jackson & Bruegmann, 2009). In essence, the results suggested that even ineffective or underqualified teachers were malleable and teaching quality was better when teachers' peers were stronger. Therefore, organizational processes are well recognized as being beneficial for education quality regardless of individual teacher qualifications, and such processes have been identified as weaker within the rural education settings of China.

The scope of teacher responsibilities may contribute even more significantly to disparities in rural Chinese education systems. An example is the many rural one-teacher schools, where a single individual is required to address all course subjects in a multi-grade teaching capacity. In these settings the teacher must assume all roles and responsibilities for managing the school, such as cooking, cleaning, and maintaining the facilities, with only a minimal level of infrastructural support and typically an inadequate level of educational training. Such conditions constitute the most severe cases of education inequity, particularly within specialized academic disciplines that are often unfamiliar to the teachers (e.g. music, art, foreign languages). While the exact number of remaining one-teacher schools has not been officially reported in the wake of the Rural School Mapping Adjustment[4], which has greatly consolidated the number of rural schools over the past decade, recent literature suggests that as many as 67,000 one-teacher schools exist in rural areas of China (Zhang, Yang, Fan, & Huang, 2015). In these settings, the level of teacher qualifications, the capacity of teachers to teach specialized subjects, the minimal influence of peer networks on teacher learning, and the inadequate amount of time for lesson preparation make education quality difficult to achieve.

In summary, the relevant literature strongly describes a human resource disparity among rural educational settings, whereby there are not enough qualified teachers. In addition, research suggests that without processes to balance teacher quality between rural and urban settings, education equity may worsen over time.

Technological resources

Technological resource inequity can result in *digital divide*, which refers to ICT usage that expands education inequity due to the developmental advantage provided by ICT being used in an imbalanced way (Van Dijk, 2005). Research suggests that digital divide involves two layers: first-level issues (e.g., resulting from the shortage of resource availability) and second-level issues (e.g., resulting from the difference in resource usage) (Hargittai, 2002). That is to say, the most common measures of technological resources relate to the degree of resource access and the capabilities or procedure of resource integration.

In alignment with UNESCO's (2015a) recommendation for ICT policies to focus on integration that *serves* rather than *drives* strategic advantage in education (p. 56), national initiatives have made considerable advances in balancing access and developing the capability to connect educational resources between urban and rural settings. For example, since 2000, a series of *Modern Distance Education (MDE) Projects* (Wang & Li, 2010; Ying, 2007) directed over 11 billion yuan toward educational ICT initiatives, which included the investment in over 440,000 DVD players, 41,000 computer labs, and 275,000 satellite receivers for establishing school internet access throughout China. In addition, the MDE Projects and several others, such as the *National Program for Rural Teachers through Summer Vocation* (Shi, 2007), began training teachers to use the newly provided technological resources, as well as compiling a digital archive of high quality teaching resources that is freely available for integration in any location. These national initiatives all have been driven by a vision to balance education quality between regions and have greatly contributed to balancing the first layer of digital divide, technological resource access.

To illustrate national development over the past decade, regional exploration of technological resources shows that the current status of infrastructure supporting schools' internet access is near complete. **Table 2** shows that the proportion of schools without internet access is greater among rural areas (11%) as compared to urban areas (3%), which equates to 6% and 1% of total schools without internet, respectively. While illustrating rural disparity, this data suggests that the capacity to share resources between schools is now available for the majority of disadvantaged students inhabiting rural areas of China.

[4] A comparison of 2003 and 2015 *Educational Statistical Yearbook of China* data shows the total number of rural primary and secondary schools have been reduced by 241,985 and 21,000, respectively.

Table 2. Distribution of internet connectivity, by region

	Student enrollment [1]	Total schools		Schools without internet access	
	(national %)	(1000s)	(%)	(regional %)	(national %)
Rural	23	~136 [2]	53	11	6
Suburban	43	~76	30	5	1
Urban	34	~44	17	3	1
Total	100	~256	100	--------	8

[1] Total student enrollment = 163,785,323; Includes primary and regular secondary schools

[2] Excludes the total number of one-teacher schools, which is estimated at greater than 67,000 schools.

Source: 2015 data from the *Educational Statistical Yearbook of China.*

Table 3. National Distribution of ICT resources, by region

	Computers (%)	Computers used for instruction (%)	Tablets (%)	Networked multimedia classrooms (%)
Rural	20	20	15	20
Suburban	37	38	31	40
Urban	43	42	54	40
Total	100	100	100	100

Source: Authors' calculation from 2016 data in the *Educational Statistical Yearbook of China.*

Further analyses of technological resources show similar access patterns with an urban-skewed distribution. **Table 3** shows that the rural-urban distribution of resources is relative to the percentage of the total population inhabiting each area. However, when considering that the percentage of rural student enrollment is spread across greater than three times more schools than urban student enrollment (as shown in **Table 2**), it is clear that rural students have much weaker access to technological resources for learning. It is also worth noting that these statistics do not consider the students attending the greater than 67,000 one-teacher schools, which are conceptually the most disadvantaged from this perspective.

The use of technological resources is a separate and more serious issue in China. Li and Ranieri (2013) showed that regardless of the type of internet usage (e.g., personal or academic), urban children used the internet more frequently than rural children. Additionally, Li and Ranieri's study showed that students of rural and migrant schools displayed lower scores on all levels of internet inequality indicators (digital access, autonomy of use, social support, internet use, and self-efficacy) than their urban counterparts. Similarly, basic computer awareness and literacy education is more common in urban, as opposed to rural areas (Yang et al., 2013). Therefore, rural students are not only disadvantaged in access, but also by the process of technological resource integration in China when compared to students inhabiting urban areas.

Summary of educational resources

To synthesize the related topics of human and technological resources in education, research suggests that rural students are disadvantaged in comparison to urban students in many ways. However, the most serious threat to education equity seems not to be the basic access to technological resources, because the statistics show high percentages of school internet connectivity in all areas. Rather, the human factors of teaching quality and technological utilization are the issues. Furthermore, teaching quality and technology utilization are also issues that are more complicated to resolve. If such problems are not addressed, education equity between rural and urban students is very likely to worsen rather than improve, as a result of educational ICT and the digital divide.

CASE EXAMINATIONS: COMPUTER-SUPPORTED COLLABORATIVE TEACHING MODELS

The overarching goal of ICT mitigation strategies in China has been to leverage capacity for sharing human and technological resources to improve education quality among disadvantaged students in rural areas[5]. The main factor that sets China's implementation strategy apart from other exemplary projects (e.g., South African Department of Education, 2004; UNESCO, 2015b) is the scope of initiatives. To our knowledge, China is the first large nation to implement an ICT strategy that attempts to standardize quality across the entire country. **Figure 1** illustrates the direction of this national ICT strategy connecting rural and urban regions. Of the various strategies that exist for sharing resources through ICT, two computer-supported collaborative teaching approaches (Yang,

[5] 2016 data from the *Educational Statistical Yearbook of China* reports greater than 37 million students are enrolled in rural education which was the equivalent of ~23% of total student enrollment within primary, regular junior secondary, and regular senior secondary education levels.

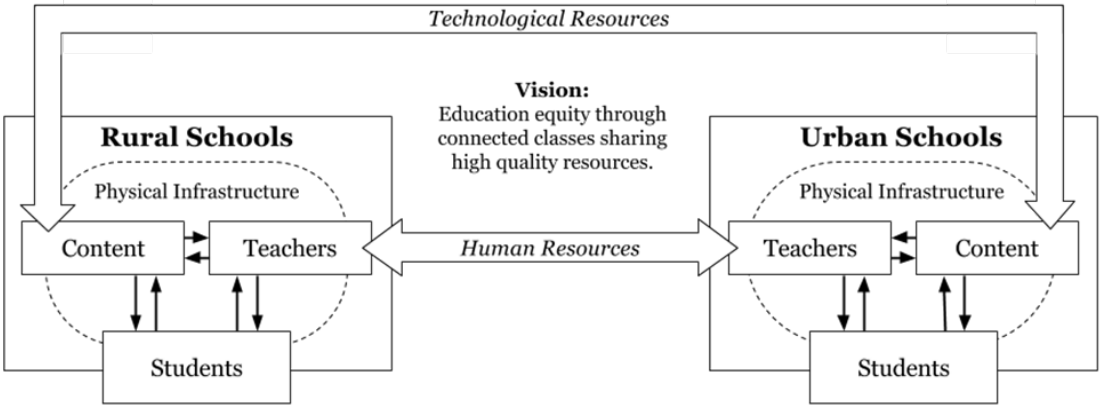

Figure 1. Direction of unique nation-wide educational ICT strategy in China

Zhu, & MacLeod, 2016) have been showcased in China to provide the greatest potential: (1) *the on-site leadership model*, in which an underqualified teacher indirectly connects with an experienced teacher through ICT to improve their personal teaching quality for students; (2) *the off-site leadership model*, in which an underqualified teacher directly connects with an experienced teacher for on-the-job training while the off-site experienced teacher improves teaching quality for students in the disadvantaged area. In both situations, computer-supported collaborative teaching refocuses the traditional purpose of ICT integration from personalizing learning processes for individuals to improving learning quality for large populations. This section describes a case for each of the two approaches (on-site and off-site leadership models) based on real scenarios from an education equity perspective.

Case 1: The On-site Leadership Model

Overview

The on-site leadership model represents a computer-supported collaborative teaching approach where the on-site teacher of a rural disadvantaged school facilitates the educational process for students through a combination of traditional and digital content delivery (Yang et al., 2016). By integrating high quality technological resources (e.g., pre-recorded instructional videos) provided by experienced off-site teachers, on-site rural teachers are able to customize instruction for rural students. In this model, the off-site teacher is only an asynchronous instructional figure. Furthermore, there is typically no direct communication between on-site and off-site teachers in this model.

Open online teaching units

Open online teaching units are freely accessible educational lessons that can provide formal ICT-supported instruction (e.g., Coursera, n.d.; Kahn Academy, n.d.) and represent a case for describing the on-site leadership model. In China, a massive archive or open online teaching units have been universally provided as a result of educational ICT initiatives and the off-site leadership model teaching approach began gaining popularity in 2014, due to the implementation of the *One Teacher One Lesson Program*[6] (National Center for Educational Technology, 2017a). As part of this program, experienced teachers throughout China have recorded the instructional delivery of their best classroom lesson. Recordings are then reviewed for quality, archived, and openly shared via the National Public Service Platform for Educational Resources (National Platform) (National Center for Educational Technology, 2017b).

As of June 2017, greater than 7,000,000 lessons have been shared on the National Platform, including instructional delivery of lessons for 21 primary school subjects, 26 junior secondary school subjects, and 24 senior secondary subjects (National Center for Educational Technology, 2017a). On-site teachers in disadvantaged areas may now search and select from a huge database of high quality lessons to integrate into their classroom in ways that compliment or replace their traditional instruction for the purpose of improving quality.

[6] This name is translated from the Chinese title "一师一优课、一课一名师."

Examining the effects

Universalizing access to experienced teachers

As a result of open online teaching units, rural students are digitally connected to the best instructional delivery of experienced teachers working within the qualifications of their educational specialization. That is to say, educational ICT is providing conditions for teaching quality to become location independent. From an education equity perspective, this computer-supported collaborative teaching approach is the most advantageous in the disadvantaged environments of one-teacher schools. In these disadvantaged areas, teachers' time and qualifications are serious issues (Zhang et al., 2015). To manage a multi-grade classroom, teachers choose between two less than ideal options. They can divide their time between individual students, which leaves young students partially without teacher direction, or, they can simultaneously teach students with vastly differing academic proficiencies, which provides sub-optimum learning opportunities. Open online teaching units have supported a shift in teachers' roles from class lecturer to side-by-side student learning facilitator (Yang et al., 2016). In this case, the teachers' lesson planning and delivery time can be redirected toward 1:1 student-to-teacher interaction, which offers more customized educational opportunities to students. In addition, it allows teachers to account for the individual differences and academic proficiencies of their students. These factors greatly improve the access to quality education among rural students.

Universalizing access for teacher development

Open online teaching units are supporting the growth of teachers working in rural areas. As a result of remarkable rural-urban population differences (Ministry of Education, 2016; National Bureau of Statistics of China, 2016), rural teachers simply operated in circumstances with smaller peer support networks. However, open online teaching units have provided vast access for new asynchronous forms peer observation, which can expand their content and pedagogical knowledge. Through self-reflection over time, this emerging process supports the growth of rural teachers in ways that will continuously raise the quality of rural teaching capabilities.

Improving teacher interest for ICT integration

The development and sharing of open online teaching units has vastly increased teachers' perceived usefulness of ICT integration in the classroom. The second layer of digital divide is a human-derived problem (Abascal et al., 2016; Hargittai, 2002). That is to say, it is caused by the improper use or neglect of available ICT. After technological resources are accessible, the only way to narrow the second level of digital divide is to increase technological awareness, encourage technology acceptance, and then provide training to develop teachers' digital literacies and technical pedagogical content knowledge. Simply providing technology is not enough to solve the digital divide that is creating inequity between rural and urban students. Instead, the how technology is used, and how can teachers be convinced that there is value in using technology for teaching purposes are the critical issues. Thus, initiatives perceived as very useful, such as open online teaching units through the on-site leadership approach, offer much opportunity for motivating the proper forms of ICT integration in education.

Case 2: The Off-site Leadership Model

Overview

The off-site leadership model represents a computer-supported collaborative teaching approach in which an experienced off-site teacher, usually from an urban area, assumes an interactive leadership role in the instructional process of a disadvantaged rural school (Yang et al., 2016). In this approach, the experienced off-site teacher is fully responsible for choosing learning content, organizing the course schedule, and delivering instruction to students via one-way or two-way teleconferencing technology. The less experienced on-site teacher contributes in a supportive role that primarily assists with the organization and maintenance of students in the remotely connected rural class. Unlike the on-site leadership model, where no direct communication exists between teachers, the off-site leadership model requires regular communication between teachers throughout the duration of the course. For example, to account for geographic separation, the rural teacher must communicate student progress to the more experienced urban teacher. Meanwhile, the urban teachers provide mentorship to the less experienced rural teachers to ensure their continued professional development.

The Remote Synchronous Classroom (RST)

The RSC refers to the connection of geographically distant classrooms through ICT for parallel instructional delivery of lessons to multiple locations simultaneously. The RSC provides an example for describing the off-site leadership model and has largely become possible to support education equity due to nation-wide educational ICT initiatives. The deficit of teaching capabilities in rural areas for specialized subjects like art, music, and English, has contributed to RSC's popularity.

The most common form of RSC connects instructional delivery between two classes. However, the RSC has been documented in some cases to connect greater than two classes at once. From an education equity perspective, the RSC has primarily been used under three sets of conditions: (1) the complete RSC, where everything is shared between classes (e.g., Yang, 2014); (2) the partial RSC, where only instruction is shared between classes (e.g., Audio-visual Station of Enshi, 2013); (3) the exclusive RSC, where instruction is remotely delivered to only the disadvantaged group(s) of students (e.g., Song Education, 2015).

The cities of Enshi in Hubei Province and Xian'an in Shanxi Province provide a good opportunity to showcase the emerging use of RSC for education equity in China. In Enshi, there are 655 primary and secondary schools, including 569 rural schools and 526 one-teacher schools. To date, 22 urban schools and 22 one-teacher schools have teamed together and built remote synchronous classrooms (Yang, 2016). In Xian'an, there are 128 primary and secondary schools, including 28 one-teacher schools. Over the past three years, Xian'an has established seven experimental groups of collaborative teaching communities, which have benefited over 600 students and 40 teachers in 31 rural schools (Liao, Cheng, & Wu, 2017). In the following section, real examples of RSC usage are described from Enshi and Xian'an. Examples of the complete RSC and partial RSC will be illustrated from Enshi data, while the exclusive RSC will be illustrated from Xian'an data.

Examining the effects

Universalizing access for curriculum offerings

A primary benefit of implementing the off-site leadership model is the capabilities it provides to expand curriculum offerings in rural areas, as is particularly in high demand among many one-teacher schools (Zhang et al., 2015). In situations where teachers are unqualified or underqualified to teach courses, students' learning suffers. In the worst scenarios, courses may simply be omitted from students' academic schedules due to the lack of specialized knowledge necessary for instruction. This is not only an issue of education equity, but in some cases also a national policy violation (cf. State Council of the People's Republic of China, 2017). National policy mandates the training of students in Chinese, mathematics, art, music, and ideological and moral subjects starting in first grade. However, many specialized subjects such as music and the arts tend to be overlooked without implementation of technological solutions like the RSC.

To illustrate the depth of the RSC in supporting curriculum expansion, Mr. Hu, a teacher in Mao Batang Primary School, which is a one-teacher school located in a rural area of Enshi stated, "I have not studied English or music, so it is difficult for me to deliver the content of these courses to my students. However, with the help of the remote synchronous classroom, my students can now learn from [other] teachers when studying outside of my specialization" (China Education News, 2015). In addition, a student representative of the Caiqiao One-teacher School in Xian'an, stated that, "Since the RSC has become available, I can now study art and music classes. I think the content of the RSC classes are very rich, and I like them very much" (Xiong, 2016). Both of these testimonials describe a situation where the availability of curriculum has been expanded for students of rural areas, providing a positive force toward universalizing education quality. That is to say, the RSC has improved the quality of rural instruction through (1) connecting rural students with more experienced urban teachers, as well as (2) balancing basic opportunities to learn the same array of curriculum that is a well-recognized standard in urban areas.

Universalizing access for teacher development

The RSC provides considerable advantages for addressing the issue of less engaging school-level processes contributing toward the growth of inequity between regions over time (Hallinger & Liu, 2016). Prior to the RST, organizational processes and on-the-job training of rural schools was suggested as less engaging and rigorous (Wang et al., 2017). This phenomenon may be explained by population influence, which is significantly less dense among rural areas. That is to say, organizational structures with less teachers relate to less mentorship, collaboration, and competition. However, through the introduction of an experienced off-site teacher through the RST, rural teachers now have new opportunities to experience critical educational processes such as peer class observation and novice teacher mentorship, which are processes shown to positively influence student achievement (Jackson & Bruegmann, 2009).

Forming student-to-student intercultural connection

The RSC is increasing the level of engagement and widening the perspective of student thinking in the classroom. To describe this effect, a student representative from a one-teacher school in Hupo stated, "Although I could only see the teacher on the screen, she taught us dancing and interesting songs. The music class was more interesting than ever before" (Gong, 2015). Furthermore, a representative student from the Cuiba Town Primary School of Enshi said:

This kind of class is like a video chat and it lets me feel the power of education information technology. I think that the RSC is interesting and challenging. Students of two classes are now learning at the same time, so we could

Table 4. Technical implementation criteria

Description	On-site leadership	Off-site leadership
Collaboration type	Asynchronous	Synchronous
Visual/audio components	√	√
Teleconferencing components		√
High-speed internet	Intermittent is okay	Stable and required

learn from each other, and compete with each other, which really inspires our interests for learning (People's Daily Online, 2016).

In addition, Mr. Liu, the director of the one-teacher school, reported that "through the RSC, students in Hupo One-teacher School have widened their horizon, which has caused them to become more active. The RSC has opened a wonderful door for the students, and let the outside world into our school" (Gong, 2015). Both of these representative quotes illustrate the depth of opportunity for increasing engagement that can be offered through the RSC. This is critical for balancing education equity because regardless of education quality, the perspective of students from areas of different populations varies greatly. Opportunities like this, to learn under conditions that widen the vantage point for understanding, both in rural and urban settings, are critical for improving the quality and balance of education equity in China.

Stimulating a trend of reverse migration

The several decade trend of decreases in rural school enrollment is not only due to economically driven migration (e.g., National Bureau of Statistics of China, 2016; Wu, 2013), but also largely influenced by the known differenced in education quality between rural and urban regions (Gu, 2016; Li & Ranieri, 2013). In recognizing that ICT can impart educational quality that is universal, many migrant families are now opting to return their children to the schools in their home residency. To describe this phenomenon of reverse migration, Mrs. Wang stated:

The hardware facilities in our village school are not bad in comparison to urban schools. In addition, the village school is near home and convenient. After careful consideration, the whole family agreed to let my child return to the village school (Ke & Chen, 2016).

In this scenario, Mrs. Wang has described how national ICT initiatives have elevated the quality of learning conditions in rural schools. This is particularly true within the one-teacher school in the Xiangzhou district of Xiangyang to which her child reverse-migrated (Ke & Chen, 2016). The Wang family's decision to allow their child's reverse migration is not unique. In fact, it has been reported that the student enrollment of 23 out of 25 one-teacher schools in Xian'an have increased from 352 to 481 students between the fall of 2014 and the spring of 2016 (Cen, 2016). This snapshot of reverse migration represents a notable turning point for education equity, as to the best of our knowledge, this is among the first evidences suggesting migration toward rural areas in several decades.

Discussion of Implementation Criteria and Strategies

To synthesize the two computer-supported collaborative teaching approaches (Yang et al., 2016), a comparison of the required implementation criteria, as well as a proposal of implementation strategy are discussed. As seen in **Table 4**, the main difference between the two models is the synchronous versus asynchronous nature of collaboration. Both models require some type of audiovisual ICT components. However, the synchronous nature of the off-site leadership model also requires more advanced teleconferencing components and stable high-speed internet in order to be effective. Due to this, the on-site leadership model is best in situations where technological infrastructure is limited and may not yet be capable of delivering smooth synchronous computer-mediated communication. The off-site leadership model should be employed only where the reliability of technological infrastructure is capable of supporting effective collaboration.

From the perspective of education equity, each computer-supported collaborative teaching approach should be strategically used to maximize desired benefits. As shown in **Table 5**, the on-site leadership model should be used to improve provisional quality where teachers are unqualified to teach a class, or constrained by time in multigrade teaching environments. This model does not provide a dynamic professional development opportunity for the teacher. However, the on-site leadership model does provide opportunities for rural teachers to observe high quality peer teaching. In addition, the on-site leadership model can be implemented very quickly and used for long durations to address the lack of quality curriculum, lack of teacher time, or lack of appropriate curriculum that matches students' individual academic proficiencies.

Table 5. Recommended implementation strategy

Description	On-site leadership	Off-site leadership
Implementation speed	Fast	Slow
Duration of use	Long term	Medium term
Teacher workload	Increases efficiency	Maintains schedule
Professional development	Low quality	High quality
Teacher type	Unqualified teacher	Developing teacher
Type of quality improvement	To account for weakness	To expedite mastery

Conversely, the off-site leadership model should be used to balance access to quality instruction of specialized subjects. In addition, the off-site leadership model should be used to provide high quality and dynamic teacher mentorship opportunities for less experienced teachers. With this model, the implementation time period should be longer, as organizational arrangements are required for implementation, and teacher mentorship should not be a one-time experience. However, the duration of off-site leadership model implementation should not be permanent, as on-site teachers are learning from an off-site teacher with the intent to independently manage the class after their skills improved.

In summary, both computer-supported collaborative teaching approaches leverage the capacity of nation-wide educational ICT initiatives to balance education equity by universalizing the quality opportunities for disadvantaged rural students and teachers. The main difference between the two approaches is that the off-site leadership model provides more dynamic instructional delivery (for students) and professional development (for teachers). In contrast, the on-site leadership model provides greater opportunities for increasing the efficiency of rural teachers. Due to the mentorship component of the off-site leadership model, workload efficiency should not be expected to increase. However, that is because the teachers' developmental opportunities can be more personalized and beneficial.

CONCLUSION

Education equity is one of this century's most significant problems (UNESCO, 1990, 2000, 2015a), although there are currently no effective large-scale solutions. Particularly in China, the rapid pace of social transformation has created rural vulnerabilities in education which remain an important but unsolved challenge. However, this challenge brings opportunity. The study presented here highlights innovations in Chinese primary and secondary education which emerged through nation-wide educational ICT initiatives over the past decade.

By reviewing the human and technological resources of the compulsory nine-year education system, this study supports the EQI hypothesis (Lucas, 2001; Yang & Wan, 2015) and its theoretical justification of inequality post-universal enrollment of students in education, as rural students continue to appear disadvantaged by circumstance. This is particularly true in relation to teachers' educational attainment (Ministry of Education, 2016), the organizational processes that shape teacher development (Hallinger & Liu, 2016; Wang et al., 2017), and the scope of teacher responsibilities which impact their teaching effectiveness (Zhang et al., 2015). When considering all of the remote one-teacher schools, more than 200,000 schools are critically affected by all of these issues in rural and underdeveloped areas. However, educational ICT offers great potential for remedying this dilemma. The issue of a digital divide (Hargittai, 2002; Van Dijk, 2005) now appears to be less related to access, and more related to utilization. Therefore, much emphasis should be placed on teacher training and assessment of ICT integration, to support more appropriate utilization of ICT resources in rural areas. Our examination of two cases suggests that computer-supported collaborative teaching (Yang et al., 2016) is a positive method for beginning addressing this issue.

By examining two cases that highlight collaborative teaching in China, this study assesses the large-scale potential of policies for national ICT implementation in addressing matters of education equity. Open online teaching units provide a representative example of how the on-site leadership model is being implemented. Strategically, this model should be used to address curriculum deficits for long term durations, particularly in situations where teachers are unqualified, implementation must be fast, or technological infrastructure may still be developing. In contrast, the RSC offers a representative example of how the off-site leadership model is being implemented. This model is conceptually similar to the on-site leadership model. However, the synchronous nature offers a more dynamic student learning experience and supports a higher quality professional development opportunity. In either case, collaborative teaching provides opportunities to universalize access to quality education for students and teachers in rural and underdeveloped areas.

Education equity (Gillborn & Deborah, 1990) is a complex social issue that requires multifaceted attention. It is important to note that this study qualitatively described the most promising opportunities of educational ICT utilization in China from an equity perspective at the primary and secondary level of education. Much additional

research is needed to further explore the specific pedagogy of these computer-supported collaborative teaching approaches, as well as to develop professional training strategies, and assess the real impact of collaborative teaching on student learning. In addition, future research should explore student and teacher perceptions of these approaches to guide the improvement of teaching and learning effectiveness.

To conclude, much research and policy, particularly that of the United National Sustainable Development Goals, have recognized education equity as a critical global issue and noted the lack of large-scale ICT solutions to support the execution of policy agendas. The same applies to China; however, the large population, mountainous geography, and fast-paced rate of economic development has made the issue much more prominent. Computer-supported collaborative teaching models emerged in China as a nation-wide innovation that offers large-scale potential for promoting education equity (Yang et al., 2016). To our knowledge, few nations have attempted such an approach at this scale. All efforts to refine understanding of such approaches are likely to strengthen educational benefits and increase teachers' acceptance of education modernization in China and throughout the world.

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