Factors Determining Digital Divide in Ghana’s Basic Schools

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Abstract: This paper explores the concept of digital divide (DD) in Ghana’s basic schools in Sekondi-Takoradi Metropolis in Western Region. We tested the ICT culture variables as well as school location factor in respect to school’s digital divide. A survey sample contained 17 regional city schools from three different locations – central city in the region, towns away from the central city, and village schools. The survey instrument was developed with ten ICT culture variables. The variables in the instrument met the Cronbach’s Alpha threshold value of $\alpha = 0.70$. Data was analysed with Descriptive statistics, Hierarchical Cluster analysis, Independent t-test, and Canonical discriminant analysis. We found that school location did not determine the schools DD, nonetheless the schools were digitally divided – 2 clusters were found among schools. This DD was determined by certain ICT culture variables: Teacher’s ICT competences and the usage of ICT in Teacher’s professional practice were paramount.

Keywords: Digital Divide, School ICT Culture, school digital disparities

1. Introduction

ICT has continued to transform the way of life of individuals, communities, and nations. ICT comes with the glitter of hope for developing nations in the form of improving the standard of living through quality and efficient education, good and contemporary skills for today’s knowledge driven job market, offer opportunities for social inclusion and mobility, access to global opportunities and knowledge repositories. However, developing countries still appear among the least digitally advantaged nations [1]. This potential marginalisation coupled with social and economic exclusion results of Digital Divide (DD) affect African schools. DD in the global context is described as the "gap between individuals, households, businesses and geographic areas at different socio-economic levels with regard both to their opportunities to access information and communications Technologies (ICT) and their use of the internet for a wide variety of activities" [2]. In an empirical study [3] DD was described as inequity in the deployment and application of ICT among people. In more details, DD is described as the existence of gaps in the dimensions of access to ICT use, ability to use ICT, actual use of ICT and finally the impact of ICT use [4]. The DD conceptualization incorporates the lack of digital access skills, the lack of usage access, the lack of material access and the lack of mental access [5]. Measuring DD has been complex and extremely technical [6], [7]. Researchers and professional bodies such as ITU and UNESCO use varying parameters for this exercise. In the works of [3] seven DD parameters have been identified: 1) ICT Opportunity Index, 2) ICT Development Index, 3) E-Readiness Index, 4) Network Readiness Index, 5) Digital Access Index, 6) Mobile/Internet Index and 7) Technology Achievement Index. Across all parameters, most common indicators for measuring DD have been in the following dimensions: 1) Human
Resources component, 2) Perception and Attitudes of the Human resource component, 3) Support and Technical Resources and 4) Material Resources and 5) Motivation.

Focusing on DD in schools’ context we may assume that any situation that prevents the maximisation of the advantages ICT such as the availability of ICT infrastructure, empowerment to use ICT resources, appropriation of ICT and formation of positive attitudes towards ICT in daily and professional endeavours amounts to DD. We bundled the different ICT variables potentially influencing DD in schools into the concept School’s ICT culture that we investigated from the head teacher’s perspective. School’s ICT culture variables tested in this study are head teacher’s perception of (1) teacher’s professional ICT competences, (2) training support for teacher’s ICT use, (3) ICT usage in teacher’s professional practice, (4) Headteacher’s ICT usage, (5) opinion on using ICT for educational purposes, (6) Headteacher’s projection for school’s ICT use, (7) presence of school’s ICT strategy, (8) level of school’s ICT infrastructure, (9) ICT resources’ impact on teacher’s work, (10) perceived inhibitors of using ICT in teaching and learning.

Researchers [6] analyzed DD in the context of spatial factors towards technology utilisation’s and had the results that much as other factors such as political, legal, access and rate of adoption act as factors influencing technology utilisation, spatial conditions equally play a pivotal role in impacting on the extent of detail utilisation in nations. We assumed that spatial location of schools (the regional capital city, in towns away from the regional capital or in the villages) might be another important factor determining school’s DD.

The challenges of inequities in the Sub-Saharan Africa (SSA) ICT terrain needs to be addressed as a matter of importance towards the overall development of the region as asserted by researchers [8]. Ghana is a Sub-Saharan African (SSA) country that falls in the brackets of digitally disadvantaged nations. Ghana is known for her efforts to create a knowledge-based economic system [1], [9]. Ghana’s educational sector has been earmarked to lead in the developing of digital knowledge, skills and competencies in school beneficiaries – the underpinning policy is ICT in Education [10] and an ICT agenda dubbed Basic School computerisation Programme. Over the past few years, government of Ghana in pursuant of the Basic School Computerisation Agenda have distributed 60,000 laptops to over 2,500 basic Schools for technology integration in teaching and learning. In addition, over 60,000 teachers have undergone training in digital literacy and are to be supplied with laptops for their professional use under the Teacher Laptop Project [11]. In this paper we wanted to take an in-depth look to see if this overtly positive picture of schools ICT situation is liable and whether there are still digitally divided basic schools, and what factors might cause this DD.

2. Objectives

This paper investigates the state of DD in Ghana’s basic schools in respect to ICT culture variables and the schools’ spatial location. The sample of schools for testing the factors influencing the DD was taken from Sekondi-Takoradi Metropolis in the Western Region. The following research questions were formulated:
RQ 1: What is the level of ICT Culture variables in the sample schools?
RQ 2: Is there a DD among the sample schools based on ICT Culture variables?
RQ3: What ICT Culture variables influence the DD significantly in the sample schools?
RQ 4: How does the school location determine DD in the sample schools?

3. Methodology

The sample for the study (N=18) was taken from the schools located in the Sekondi-Takoradi Metropolitan Assembly (STMA). Three school-location types were selected (the
regional capital city, in towns away from the regional capital, in the villages) and 6 schools from every location were randomly selected from the list of STMA schools. The survey instrument was developed containing 10 ICT culture variables: (1) teacher’s professional ICT competences, 2) training support for teacher’s ICT use, 3) ICT usage in teacher’s professional practice, 4) headteacher’s ICT usage, 5) opinion on using ICT for educational purposes, 6) headteacher’s projection for school’s ICT use, 7) presence of school’s ICT strategy, 8) level of school’s ICT infrastructure, 9) ICT resources’ impact on teacher’s work, 10) perceived inhibitors of using ICT in teaching and learning. We used the customised rubrics from Institute for Capacity Building UNESCO for African teachers [12] and EU rubrics for measuring ICT in Education [13] for designing some variables. Each variable included several survey items that are in more details presented in the results section 4.1.

The internal consistencies of the instruments were calculated using Cronbach’s Alpha (\(\alpha\)) – all the variables met Cronbach’s Alpha Coefficient threshold value (\(\alpha > 0.7\)). For summarizing the ICT culture based on the survey items, for each variable we computed the composite scores by converting each raw score to a z-score, added up the individual Z scores and found the mean of the composite. The paper-based questionnaire was sent to the Headteachers of the schools who had to fill it in. We received responses from 17 schools from the 18 initially sampled.

Descriptive statistics were used to build up the picture of the status of ICT culture in the sample schools in respect to the variables of the survey instrument. In attempt to find out if the sample schools differ digitally, a Hierarchical cluster analysis using Ward’s method was used. We used the compound variables for clustering the schools based on ICT culture. Two clusters were found that showed remarkable disparities leading to their classification namely Cluster one (10 members) and Cluster two (5 members). The independent t-test method and Canonical discriminant analysis were used to describe the clusters based on ICT culture. Two sets of discriminant analysis (stepwise and enter the independents together) were run to identity the predictors of DD among the ICT culture variables. We present the data from the latter analysis. The variable School ICT infrastructure failed the tolerance test and consequently removed from the analysis. To test the influence of spatial variable on DD in schools the Canonical discriminant analysis with the school-based digital variables as predictors and the school location as the group variable was run.

This paper reports on the partial results from the pilot study conducted in one district of Ghana. We have also collected the teacher’s responses that will be further compared with the results of school leaders to overcome the subjective answers the Headteachers’ might have made about teachers’ competences and other ICT culture components in their schools. The main study in all the regions of Ghana is planned to follow to estimate the DD in Ghana’s basic school system.

4. Results

4.1 ICT Culture Components in Schools

The study measured ICT culture of seventeen (17) schools based on a ten (10) point school-based ICT culture composite variables. The general overview of the state of School ICT Culture across the sampled schools as perceived by the leaders of schools is provided in Table 1. The overall Teacher Professional ICT Competencies (SBf1) were just above average (\(M=2.03\), \(SD=0.868\)). Notwithstanding, some high score on some aspects of SBf1 suggest schools are involved in ICT practices. The outstanding competencies identified included Teachers’ knowledge of inspiring their learners using ICT and actual application of using ICT resources to inspire the pupils in their class.
<table>
<thead>
<tr>
<th>ICT culture variables</th>
<th>N</th>
<th>Min.</th>
<th>Max.</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>(SBf1) Teacher’s Professional ICT Competencies (SBf1)</td>
<td>17</td>
<td>1</td>
<td>4</td>
<td>2.03</td>
<td>0.868</td>
</tr>
<tr>
<td>(SBf3) Training support for Teacher’s ICT use (SBf3)</td>
<td>17</td>
<td>1</td>
<td>3</td>
<td>1.12</td>
<td>0.666</td>
</tr>
<tr>
<td>(SBf4) Perceived inhibitors of using ICT in teaching and learning (SBf4)</td>
<td>17</td>
<td>2</td>
<td>4</td>
<td>2.92</td>
<td>0.612</td>
</tr>
<tr>
<td>(SBf5) Lack of ICT usage for teacher’s professional practice (SBf5)</td>
<td>17</td>
<td>1</td>
<td>4</td>
<td>3.00</td>
<td>1.01</td>
</tr>
<tr>
<td>(SBf6) Opinion on using ICT for the purpose of education (SBf6)</td>
<td>17</td>
<td>3</td>
<td>4</td>
<td>3.47</td>
<td>0.395</td>
</tr>
<tr>
<td>(SBf8) Perceived impact of interventions on teachers’ ICT use (SBf8)</td>
<td>17</td>
<td>1</td>
<td>3</td>
<td>1.99</td>
<td>0.444</td>
</tr>
<tr>
<td>(SBf9) Headteacher projections for school’s ICT use (SBf9)</td>
<td>17</td>
<td>2</td>
<td>3</td>
<td>2.74</td>
<td>0.196</td>
</tr>
</tbody>
</table>

The variable Training Support for Teacher ICT Use (SBf3), measured school leaders’ perception of teachers’ training opportunities and engagements. The overall mean of SBf3 was found to be just below average \( (M=1.12, SD = 0.666) \). It was however observed that teachers have had training in introduction courses on Internet use and office applications and a course on pedagogical use of ICT in teaching and learning as revealed by high scores responses. Meanwhile, the results showed a discouraging score on training in advances courses such as using of whiteboard or blackboard, computer use for building lessons, filmmaking and editing of lessons and working on virtual platforms among others.

The overall mean of the variable Perceived inhibitors of using ICT in teaching and learning (SBf4) was above average \( (M=2.92, SD=0.612) \) indicating the presence of many obstacles to using ICTs in teaching and learning in schools. The role of this variable was to estimate the obstacles the school leaders saw in teachers’ use of ICT in their schools. The results showed that even though teachers favour ICT in schools, ICT usage in teaching and learning was not one of the goals in the schools. The results also pointed to the fact the nature of school time organisation is an obstacle to ICT use in teaching and learning activities. Headteachers hold the view that the state of the classroom in itself is an inhibitor to ICT usage in the classrooms. Headteachers thought the pressure on teachers to prepare students towards success in examinations prevents teachers from using ICTs in their class activities.

The variable Lack of online ICT resources for supporting teachers’ professional practice (SBf5) estimated school leader’s perception on the lack of support and resources for teachers’ online professional practice. The mean of the composite variable was \( (M=3.00, SD=1.010) \) indicating that teachers’ lack opportunities to receive online support in professional practice. The results showed there is a lack of resources and support at the websites of education policy making and management bodies for teachers in respect of professional development and practice. In addition, the Headteachers indicated that websites of teacher associations and bodies equally have no portal offering resources and support for teacher capacity development and professional practices. In the view of the school leaders teachers lack a learning platform that collaborates their professional
practices and do not have online opportunities for building and enhancing their digital learning and teaching skills as peers.

Opinion on using ICT for education purposes (SBf6) - this variable estimated school leaders’ perception of the purpose of using ICT in education. The mean of the composite variable was far above average (M=3.47, SD=0.395), indicating that using ICT in education was perceived as useful.

Perceived impact of interventions on teachers ICT use (SBf8), explored school leader’s opinion of how teachers are influenced to use ICT based on Government interventions, and other supports systems available - knowledge of 21st century trends of education and general ICT resources. The overall mean SBf6 was average (M=1.99, SD=0.444). The school leaders gave a rather discouraging result that teachers ICT use is least influenced by supply of computers/laptops in schools and supply of Laptops for pupils. Headteachers further indicated that School ICT vision is not an influencing factor on how teachers use ICTs and though some Communities have government sponsored ICT centres in the schools environs they do not have an influence on teachers use if ICTs. Furthermore Collaboration between school and donor/corporate institutions, again has not influenced how teachers use ICTs in the schools.

The variable Headteacher’s projection for ICT use (SBf9), estimated the school leaders’ perceptions with regard to teachers and schools’ ICT needs in anticipation of future ICTs in schools. It indicated that most schools regarded ICT integration in schools as an urgent matter (M = 2.74, SD=0.196) - consequently, school leaders indicated that financial support towards maintenance of ICT equipment and tools, and inadequacy of computers for teachers and pupils require attention.

Presence of school’s ICT Strategy (SBf2) as a variable, estimated whether schools had a customised ICT Policy, Plan, or Agenda. The school leaders’ overall average response on the availability of ICT Strategy or Agenda for the schools was no (Md=1). The leaders claimed they have a specific written statement about the use of ICT for teaching and learning purposes; availability of official Policy document on innovation within the schools in teaching and learning methods; and for school administration. However, the following documents were mostly missing in the schools ICT strategy: specific school policy for preparing students for responsible internet behaviour, policy for using social networks in teaching and learning and time arrangements for teachers to meet, share, evaluate, or develop instructional materials and teaching approaches in collaborative scenarios. The schools used minimal incentives for promoting ICT use among teachers.

The variable Headteacher’s ICT usage (SBf7) looked at school leaders’ use of technology as sign of offering leadership in technology use. The overall average response of school leaders using ICT in the school governing was “no” (Md=1). Most Headteachers indicated that they use the computer and internet resources to search for information and deliver presentations, but they are not active users of computers for their administrative tasks, for updating professional skills, and communicating with teachers, parents and superiors officers using the email.

Level of school’s ICT Infrastructure (SBf10) variable explored the availability of ICT equipment and resources in schools. Headteachers indicated that ICT infrastructure is rather not available (Md=1). This result appeared contrary to the expectation of school’s ICT situation after Ghana’s computerisation strategies implementation - as described in the Introduction chapter. Merely nine (9) schools out of 17 had desktop PCs without Internet access for classes for students and none had PCs permanently mounted in classrooms with internet access, and eight (8) schools had computers in some teachers’ common areas but none in the school libraries. Four schools had laptops without internet access and few digital cameras; none had projector, whiteboard, tablet, scanner and photocopier.
4.2 Digital Divide of Schools based on their ICT Culture Variables

To establish the trends of Digital Divide in the sample schools, a Hierarchical cluster analysis was run with Ward’s method using the composite variables of schools’ ICT culture as an input (see Table 1). Between the schools, remarkable disparities were established leading to their classification into two clusters as shown at Figure 1. The first cluster comprised ten schools, while five schools belonged to the second cluster.

![Dendrogram](image)

Figure 1: Ward’s Linkage Dendogram of School Clusters (school within the regional capital city (WC), school in town away from the regional capital (OC), school in the village (VS))

4.3 ICT Culture Variables and Location Determining the Digital Divide in Schools

We compared the means of the composite variables in two ICT culture clusters with independent samples t-test (Table 2) that related cluster 1 with lower level of ICT teachers’ professional ICT competences and not using online ICT opportunities in their professional practice compared with cluster 2. T-test was not computed for the variable School ICT infrastructure because the standard deviation was zero. Yet, we found that all the schools in cluster 2 had a PC in class for students. In cluster 1 only 20% of schools had a PC in class.

<table>
<thead>
<tr>
<th>ICT culture in schools</th>
<th>Clusters</th>
<th>N</th>
<th>M</th>
<th>SD</th>
<th>t</th>
<th>df</th>
<th>p</th>
<th>Effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td>SBf1 Teacher Professional ICT Competencies</td>
<td>1</td>
<td>10</td>
<td>1.68</td>
<td>0.598</td>
<td>-2.87</td>
<td>13</td>
<td>0.013*</td>
<td>0.378</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>5</td>
<td>2.83</td>
<td>0.97</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SBf2 Presence of school’s ICT Strategy</td>
<td>1</td>
<td>10</td>
<td>1.25</td>
<td>0.452</td>
<td>-0.21</td>
<td>13</td>
<td>0.836</td>
<td>0.003</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>5</td>
<td>1.2</td>
<td>0.45</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>SBf3 Training support for Teachers' ICT use</td>
<td>1</td>
<td>10</td>
<td>0.97</td>
<td>0.711</td>
<td>-1.46</td>
<td>13</td>
<td>0.168</td>
<td>0.141</td>
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<tr>
<td></td>
<td>2</td>
<td>5</td>
<td>1.51</td>
<td>0.607</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>SBf4 Perceived inhibitors of using ICT in teaching and learning</td>
<td>1</td>
<td>10</td>
<td>3.05</td>
<td>0.572</td>
<td>1.431</td>
<td>13</td>
<td>0.176</td>
<td>0.136</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>5</td>
<td>2.60</td>
<td>0.558</td>
<td></td>
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<tr>
<td>SBf5 Lack of ICT usage for teacher’s professional practice</td>
<td>1</td>
<td>10</td>
<td>3.29</td>
<td>0.728</td>
<td>2.512</td>
<td>13</td>
<td>0.026*</td>
<td>0.327</td>
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<td></td>
<td>2</td>
<td>5</td>
<td>2.09</td>
<td>1.131</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SBf6 Opinion on ICT for educational purposes</td>
<td>1</td>
<td>10</td>
<td>3.36</td>
<td>0.455</td>
<td>-1.82</td>
<td>12.9</td>
<td>0.093</td>
<td>0.202</td>
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<tr>
<td></td>
<td>2</td>
<td>5</td>
<td>3.68</td>
<td>0.24</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SBf7 Head teacher’s ICT usage</td>
<td>1</td>
<td>10</td>
<td>1.3</td>
<td>0.483</td>
<td>-0.36</td>
<td>13</td>
<td>0.723</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>5</td>
<td>1.4</td>
<td>0.55</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SBf8 Perceived impact of interventions on teachers’ ICT use</td>
<td>1</td>
<td>10</td>
<td>1.89</td>
<td>0.358</td>
<td>-1.93</td>
<td>13</td>
<td>0.075</td>
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<td></td>
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<td>5</td>
<td>2.33</td>
<td>0.51</td>
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</tbody>
</table>
To find the best DD predictor(s) out we ran with SPSS enter independents together discriminant analysis with ICT culture variables as predictors and the cluster variables for grouping. One variable - School Level of school’s ICT infrastructure failed the Tolerance test and consequently removed from the analysis. The results showed one discriminant function determining DD. \[ DF_1 = -2.366(SBf5) + 1.808(SBf2) + 0.934(SBf8) + 0.852(SBf4) + 0.174(SBf7) - 0.249(SBf6) - 1.168(SBf3) - 1.174(SBf9) - 1.860(SBf1). \] This discriminate function described 100% of variance (eigenvalue 15.925). A result from the Wilks’ Lambda test indicated that the function described 100% of the system \( \chi^2 = 24.045, df=9, p=0.004 \). The group centroids for the Cluster 1 was -5.254, while that with Cluster two was 2.627. This implies that Cluster 1 was defined by the variables SBf1, SBf9, SBf3, and SBf6; while Cluster 2 was defined by the variables SBf5, SBf2, SBf8, SBf4 and SBf7.

To identify if school location determines DD of schools, another Canonical Discriminant analysis with ICT culture variables as predictors and the grouping variable was the schools’ geographical location type (school within the regional capital city (WC), school in town away from the regional capital (OC), school in the village (VS)). Two functions were found using stepwise and all variables together methods but the grouping results were statistically non-significant. In the latter analysis Wilks’ Lambda test of Function 1 through 2 described 85.8% of the system \( \chi^2_1 = 16.011, df_1=18, p_1=0.592 \), while Function 2 described 14.2% of the system \( \chi^2_2 = 3.462, df_2=8, p_2=0. 902 \). This analysis indicated that schools’ ICT culture and respective DD are not dependent on school location as could be seen already from DD clusters Figure 1.

5. Conclusions

This study involved school leaders from 17 basic schools in Sekondi-Takoradi Metropolitan Assembly situated in three different location types (school within the regional capital city (WC), school in town away from the regional capital (OC), and school in the village settings (VS)) in detecting the ICT culture in their schools. The 10 variables of school’s ICT culture were identified for predicting the schools’ Digital Divide. The study revealed that school location did not determine the schools Digital Divide. DD in the schools was rather determined by certain ICT culture variables – Teachers’ ICT competencies and using ICT in professional development were significant predictors. We found the discouraging picture in ICT resources available in schools in spite of the recent national computerization programs in Ghana. The schools lack PC classes for students, the classes are without Internet access, teachers rarely have PCs or laptops in the staff areas, classes or in libraries. Thus, for mostly missing technologies in basic schools, the availability of ICT resources variable did not come out as the predictor of DD in our analyses. In conclusion, we hold the view that in accordance with the studies [14][15] the removal of DD among schools is dependent on the human components of the school’s ICT culture.

We are going to replicate this study across Ghana to generate the overall picture of ICT culture in basic schools. The survey will cover both the headteachers and teachers’ opinions and will enable to identify and cluster the schools based on digital divide. We propose that in training for advanced ICT culture, the schools that appear to be at different level of digital culture should base on differently approached. The specific intervention methods would be more appropriate that fit to the contextual conditions of these school types. We propose not dealing primarily with schools’ technology needs for teaching as a unitary condition but rather focusing on training teacher’s ICT competences in the schools’ digital culture context, and providing them with that technology that fits and promotes their
innovative teaching. It is assumed that teachers and headteachers should be involved in creating digital culture for their schools together, the training intervention should help in incorporating ICT strategies and specific teaching practices that match to schools’ technology availability, teaching facilities and pedagogical approaches. Instead of transferring all the teaching methods from digitally flooded western culture, the new methods for achieving ICT competences in Africa’s limited digital technology conditions should be developed as a shortcut to disparity remediation. This approach could be promoted through work-place collaborative training among schools. The future without digital divide is not using more and more human and material resources for the sake of making good use of digital resources in unitary ways for all, but contextually optimizing the digital resource usage for sustainable futures in different regions so that they can benefit from their difference and innovations.

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