INTEGRATING ONLINE LEARNING IN SCHOOLS: ISSUES AND WAYS FORWARD FOR DEVELOPING COUNTRIES

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ABSTRACT

Aim/Purpose	ICT integration into classroom pedagogical practices is considered an essential aspect of learning processes in developed countries but there are issues in developing countries regarding funding, infrastructure, access, and teacher skills and professional learning. This article presents some aspects of the findings of a study in one remote region within a developing country after the implementation of a widescale ICT initiative. This study investigates issues for implementing ICT in schools in relation to teacher and school leader attitudes, access and ICT use, and improvements needed in Papua which is one of the most remote regions of Indonesia. The paper frames these issues within the context of successful online learning initiatives in developing countries and foreign aid implementation literature, with these aspects being under-researched, especially in significantly remote developing country locations.

Background	Developing countries like Indonesia have progressively introduced online learning into school management and classrooms within government planning frameworks and with initial support from foreign aid providers. While there is research available regarding ICT implementation in more urbanized contexts within developing countries, there is a gap in terms of large-scale research which is focused on more remote regions and is supported by foreign aid.
Methodology	Mixed methods including surveys and interviews were used to investigate research questions concerning teachers' and principals' attitudes, ICT access and use, and perceptions about improvements needed. SPSS software was used for surveys and descriptive analysis, and interviews were analysed through manual coding processes.
Contribution	ICT access and e-learning in schools are increasingly becoming relevant in developing country contexts, and this research paper is a preliminary large-scale study that makes a contribution through highlighting issues experienced in more remote locations. This includes specific internet and power issues and transport inaccessibility problems, which highlight the need for locally-based and ongoing coaching of teachers within schools and regions. The paper also draws on the literature about online learning in developing countries and foreign aid towards some possible success directions in isolated contexts, an under-researched area. The importance of education systems establishing ICT skills levels for students integrated across subjects, for well-coordinated planning involving partnerships with hardware and internet providers, as well as the need for school leaders being trained in establishing teacher peer support groups for ongoing coaching, are learnings for Papua and other remote locations from the comparative developing countries literature
Findings	The findings highlight teachers' and school leaders' positive attitudes to ICT in education, although the results indicate that ICT was frequently applied for administrative purposes rather than for teaching and learning. Principals and teachers highlighted some improvements that were needed including systematic training in computer skills and professional learning about the integration of ICT with teaching and learning, especially in relation to pedagogical practices, as well as the need for improved infrastructure and equipment.
Recommendations for Practitioners	The study highlights issues and potential success factors as evident in remote regions of developing countries that have achieved recognition for widescale ICT implementation in schools. This includes issues in relation to policy makers and education authorities working with foreign aid funders. Of significant importance is the need for coordinated and collaborative strategic planning including in relation to sustained professional learning towards student-oriented ICT pedagogies and skilling principals to establish a positive culture and teacher peer coaching. Particularly relevant to developing countries in remote locations is the importance of additionally addressing specific infrastructure and maintenance issues.
Recommendations for Researchers	Regarding ICT and its use for student learning, more research is needed in developing countries and, in particular, in more remote locations where specific issues, differing from those encountered in capital cities, may be evident for teachers and principals.
Impact on Society	Teachers and principals in remote locations of Indonesia such as Papua have generally positive attitudes about the benefits of online learning but need

greater ICT access for students in the classroom and also professional development regarding pedagogical practices to support students in learning effectively through online processes.

Future Research	Updated and more detailed comparative research with other developing countries, especially those with remote locations, would be beneficial to more comprehensively identify Papua's current stage of development and to design appropriate future interventions.
Keywords	education, computers, teachers, remote schools, online learning, Papua, Indonesia, school leaders

INTRODUCTION

The integration of digital technologies, networking, and digital media with education, often referred to as online learning, e-learning, ICT in education or education technology, has been a focus of school improvement initiatives in recent decades, including in developing countries. Sustainable development Goal (SDG) 4 reflects a global educationally-focused commitment to "ensure inclusive and equitable quality education" (United Nations Children's Fund [UNICEF], 2017, p. 11). Overcoming disparities to equity such as in relation to poverty, gender, and remoteness is an additional focus, with improved learning environments including technology among other strategies used to increase student learning (UNICEF, 2017). As advancements in technology, and particularly ICT, have created new challenges in education today (Gleason, 2018), a number of developed and developing countries have also been involved in the provision of equipment, networking infrastructure, and professional learning for educators. Therefore, a key purpose has been increased student learning supported by enhanced technology-connected environments, with online learning satisfaction enhanced through cognitive aspects such as quality curriculum design, scaffolded activities, and also addressing social and emotional aspects through collaborative work online and reflections (Kucuk & Richardson, 2019). Considering school environments, networked digital technologies can enable online learning through access to digital resources, engagement in collaborative environments, global communications, and the creation of multimedia content. For teaching staff working in schools, current developments in digital technologies mean that teachers' roles in the classroom need to be revisited, with teacher professional development requiring a focus on pedagogical practices relevant to online learning (Sumakul, 2019).

Developing countries like Indonesia have used many strategies over the past few decades to improve student learning outcomes, including a focus on ICT in schools and increased training to overcome lack of initial teacher preparatory programs, as well as various approaches to address poor teacher attendance and morale (Allen et al., 2018). Despite various strategies utilized across Indonesia, there has been little overall improvement in student results, with significant issues for some groups of children (Luschei, 2017). While school attendance and school completion have generally improved in Indonesia, these aspects and achievement of successful academic results have not occurred for students from low socio-economic backgrounds and for those from remote and rural locations such as Papua, Sulawesi Barat, Sulawesi Tengah, and Maluku Utara (UNICEF, 2017). Among other strategies, a key specific target for Indonesia under Sustainable Development Goal 4 is about upgrading facilities by 2030 to provide an inclusive and effective learning environment for every child through school access to electrification, computers, and the internet for pedagogical purposes (UNICEF, 2017).

Despite such development goals, there are many issues for developing countries like Indonesia regarding ICT funding, infrastructure, access, teacher skills, and professional learning. Specifically relevant to professional development is the resistance by Indonesian teachers to online processes, with an overall paradigm shift needed that is away from valuing teacher-centered approaches and towards student- centered learning (Harendita, 2013). Additionally, while major cities and schools in close

proximity may benefit from centralized government and donor-sponsored ICT initiatives, the specific needs of those schools that are in more remote regions have traditionally been overlooked. These village environments and schools may have specific environmental issues that impact on ICT such as poor quality buildings and frequent floods, these being aspects which affect longevity of hardware and internet connectivity. Given overall inaccessibility of remote places and isolation from communication, there are also issues for teachers in terms of needing particular professional development programs designed to increase ICT confidence and to support attitudinal change and build ICT integration skills (Mahdum et al., 2019).

Indeed, only limited research exists about online learning in schools in remote Indonesian locations. The current paper examines some aspects of a large-scale research project undertaken with foreign aid support in schools in Papua Indonesia.

Research questions are:
>   What are the attitudes to online learning of teachers and principals in Papuan schools?
>   What ICT access and use occurs in Papuan schools?
>   What improvements are needed?

In addressing these questions, this paper presents background research relevant to ICT teacher attitudes, ICT access and use, and developing country comparative literature and contextual information about Papuan schools, followed by presentation of the research methodology. The paper then outlines current research findings and examines some issues within the context of literature regarding successful ICT implementation in developing countries. The article also highlights issues in working with foreign aid donors and the need for local ownership and coordinated planning and implementation to ensure success and sustainable change, aspects which are under-researched and have relevance to many developing countries, including in remote regions.

BACKGROUND

ICT ATTITUDES AND PROFESSIONAL DEVELOPMENT

ICT for educational purposes, economic development, and lifestyle enhancement is increasingly emphasized as essential for future prosperity in developed and developing country contexts. Multiple benefits of the integration of ICT into schools have been outlined, including potentially leading to increased student learning. This is very important for countries like Indonesia where there has generally been little improvement in academic achievement over several decades despite considerable government spending, with students from low socio-economic backgrounds and remote locations being particularly disadvantaged (Luschei, 2017; UNICEF, 2017). Benefits of ICT for schools and for classroom learning, particularly in developing countries, include educational management efficiencies, improving reading skills, developing research capacity, problem-solving skills, increasing children's creativity, and supporting independent learning (Mohammed & Abjulghani, 2017, as cited in Mwendwa, 2017; Passey et al., 2016).

Studies have revealed that many teachers in developing countries recognise these benefits of ICT for student learning, and teachers generally have positive attitudes (Qasem & Viswanathappa, 2016). This dispositional factor has a great influence on the success of teachers' technology training (Ottenbreit-Leftwich et al., 2018). Despite some evidence of teacher reluctance (Tallvid, 2016), online learning and teacher motivation has been a subject of significant interest to researchers in educational contexts (Teo & Zhou, 2017).

Beyond attitudes, teacher and student ICT use in the classroom is influenced by pedagogical practices, teacher training, and computer familiarity (Mwendwa, 2017). Teachers need to build their skills through frequent ICT use and practice which leads to changes in pedagogy, with professional learning occurring that supports teachers in confidence building (Danner, 2014) and with the government "focusing more on how critical pedagogy can be fostered through the use of ICT" (Harendita, 2013

p. 207). Mailizar and Fan's (2019) research in Indonesia with secondary maths teachers similarly indicates the need for building knowledge of ICT relevant to the subject area and knowledge of relevant pedagogical practices using ICT. Kenyan and Tanzanian ICT improvement programs at a systems level have also focused on building teacher skills through establishing ICT competency frameworks and relevant training processes and through having highly trained mentors to work with teachers in specified subjects including ICT skills topics for students (Lloyd et al., 2016). A Kenyan ICT in schools study emphasizes the importance of leaders ensuring computer access for teachers and students and development of teacher skills (Laaria, 2013), with active school leaders being noted in various research studies as important in providing hardware and also in the provision of ongoing capacity-building opportunities for their staff regarding ICT integration into lessons (Korumaz, 2016; Prasojo et al., 2019). School leaders can be additionally supported in establishing school-based programs when centralized ICT training programs are made available for some staff to attend (including follow-up support), with these key school staff then returning to their own schools and leading ICT with other teachers (Ham et al., 2006; Laaria, 2013).

The importance of school leaders' ongoing support for their teachers after other training in ICT integration and pedagogy occurred was similarly reflected in a review of various research studies from developing countries including Pakistan, Malaysia, Kenya, and Tanzania (Ismail et al., 2020).

ICT ACCESS AND USE

Beyond issues of teacher attitude and professional learning, there are many challenges in successfully implementing online learning in schools in developing countries, with access issues including the costs of hardware and software, infrastructure concerns relevant to electricity and telecommunications, and the unavailability of specialist technical support people for maintenance purposes (Habibi et al., 2018; Kilinc et al., 2018; Passey et al., 2016). Furthermore, within these significant limitations, Karunaratne et al.'s (2018) small scale ICT study in various developing country locations, such as Bangladesh, Cambodia, Ethiopia, Rwanda, Tanzania, and Uganda, identified the lack of supporting infrastructure including "technical support", "equipment" and "maintenance" (p. 134) as the key constraint that prevents the integration of ICT into teaching and learning activities in developing countries. Of interest is that, despite lack of school ICT equipment, many teachers and students in developing countries increasingly own smartphone devices, especially in more urban locations. However, students are not generally permitted to use this equipment at school for learning (Analytical and Capacity Development Partnership [ACDP], 2015)

Relevant to ICT use in classrooms, minimal requirements in terms of teacher skills and use relate to them operating computers and also being able to undertake basic technical tasks requiring problem-solving, as well as using computers for management, lesson preparation, and teaching and assessment tasks including word processing, spreadsheets, managing databases, and creating presentations and reports (Inggit, 2011). Beyond lesson planning and supporting students in basic classroom tasks, skillful teachers integrate ICT into learning through organizing activities to develop problem-solving and critical thinking skills, and they can support students in learning with others and with experts, as well as supporting the use of ICT to solve real world problems (Kuskaya & Yasemin, 2013).

These various research studies from developed and developing countries about teacher ICT attitudes and use, access, and professional development issues and approaches are of interest and have relevance. However, few studies have occurred that are large-scale and relate to issues for significantly remote locations in developing country contexts.

FOREIGN AID DONORS

The establishment of large-scale, system-wide online learning programs in developing countries is an expensive process that frequently relies on foreign aid donors in the initial phases for planning expertise and hardware, as well as capacity building work. Generally, in these situations, donor groups, as

well as national policy makers, work in a partnership in design, planning, and implementation of resources and strategic directions. However, there are issues which sometimes arise because donor funds are available for only specified timeframes. Once initial pilots have been successfully established, there may be issues for upscaling to other contexts, or problems may arise in terms of longer-term sustainability. Research by Riddell and Nino-Zarazua (2016) regarding successful donor processes identifies key success factors for sustainable partnerships between host countries and aid donors as being local ministry officials driving the capacity development agenda, skill-building occurring at all levels, local contextualization, and the importance of national leadership. Ownership at all levels of the system is needed so that behaviors are changed across many groups of relevant people (Gillies, 2010). For sustainability, policies and procedures that reinforce new behaviors are essential so that new approaches can continue despite any personnel changes (Samoff et al., 2011). Research also indicates the importance of collaborative programs involving donors and developing countries being focusing on students rather than on management aspects, with a particular emphasis on "what the students learn" (Riddell & Nino-Zarazua, 2016, p. 33).

Of particular relevance to donor partnerships programs involving ICT is the use of pilots. Trucano (2015) warns that, once a project is over, the use of technology becomes more difficult. Hardware and software often become obsolete, with additional issues such as connectivity and internet being too expensive and the lack of technical support and ongoing professional development. Effective ICT planning and implementation requires considering the cultural contexts and specific barriers, and ensuring sustainability and long-term adaptability, as well as allowing adequate time to see the impacts and building in long-term and regular monitoring. Building local professional development processes, as well as ensuring sustained professional development through national and regional policies, are essential aspects warranting further examination (Passey et al., 2016).

DEVELOPING COUNTRY SUCCESS FACTOR FOR IMPROVING ONLINE LEARNING

Key aspects for successful implementation of online learning in developing country education systems include considering hardware, software, and ICT benefits, analyzing the contextual factors, and ongoing monitoring and updating. Wider underpinning features include implementation planning, equitable access, shared vision, empowered leaders, consistent and adequate funding, skilled personnel, and ongoing professional development and technical support. Other relevant planning features are ensuring there is a relevant curriculum framework; building engaged communities; focusing on student-centred learning; assessment and evaluation processes; support policies; and developing a supportive external context (Mishra & Koehler, 2006; Passey et al., 2016; Rogers, 2014).

There are some specific contexts in Asia which have traditionally been identified as 'developing countries' in which there are indications of ICT planning and implementation processes that have achieved some degree of success. For example, in the past twenty years, the Malaysian government developed a series of ICT pilots, working in partnership with private providers and with financial support from Japan, (and to some degree, Germany and France). These pilots have gradually been scaled up in relation to provision of hardware, internet infrastructure, teacher professional development, and administrator training addressing learner management and maintenance aspects. The most recent Malaysian plan, the Education Blueprint 2013-2025, moves beyond ICT access within specific schools. The plan focuses on increasing student learning outcomes across the education system through additional teacher training, augmentation of online content, and maximizing the use of ICT for self-paced learning by students (United Nations Educational, Scientific and Cultural Organization [UNESCO], 2013).

In the past two decades South Korea has also developed a series of masterplans regarding improving the use of ICT in education. The plans commenced with a focus on increased infrastructure and with establishment of ICT departments within the ministry to lead teacher training for ICT and the development and use of digital textbooks. In a similar way to Malaysia, the 2014-2018 South Korean plan

focused on teacher training towards student learning using ICT and personalized learning through technology. In particular, there has been a focus on competency-based education and student skills such as creativity and critical thinking, communication, collaboration, and global citizenship (Hwang, 2016). The student skills focus has been underpinned by teacher training involving a detailed set of thirteen teacher competencies and sixty-one indicators, with 'fundamentals' (creative problem-solving, social skills, flexibility, technology literacy, ethics, passion) and 'field practice' aspects (e.g., understanding future, instructional design and development) being outlined and with capacities developed within specific teacher training modules (Lloyd et al., 2016).

Other countries like Hong Kong and Taiwan have similarly had various stages for introducing ICT into schools, with key aspects being infrastructure, curriculum integration, student learning, teacher professional development, and school leadership (Kong et al., 2014). Stage one focused on infrastructure such as computer hardware (computer labs, classroom laptops) and building teacher skills, with stage two focused on digital resources for online learning and ensuring student ICT skills and use in classroom learning. The third stage has emphasized empowerment of students in using ICT in their day-to-day learning and in their lives, also highlighting the ethical use of ICT. School leader skills in planning for online learning across the school and programs to encourage parents to ensure home computers and internet availability have also been a focus in Hong Kong (Kong et al., 2014).

Singapore has been especially recognized for its planning and implementation of four ICT masterplans since 1997, which relate to infrastructure, curriculum integration, student learning, teacher professional development, and school leadership (Kong et al., 2014; UNICEF, 2018). The 1997-2002 plan "Building the foundation for technology" provided all schools with basic infrastructure and teacher training. There was a focus on changing teacher mindsets through the initial use of workshops followed up by training teams that operated in each school, with expectations of 30% of curriculum time involving ICT use and with students engaged in collaborative problem-solving activities (Kong et al., 2014; UNICEF, 2018). The 2003-2008 "Seeding innovation in Schools" plan introduced ICT Standards for students. These standards identified specific skills expectations for primary to year 4 students, year 4-6 and Secondary 1 and 2, with skills aspects being basic operations, learning with text, with multimedia, spreadsheets, communication tools and data collection tools (UNESCO, 2013). There was also a further focus on teacher training using alternative pedagogies (such as inquiry learning, blogs, wikis), recognition of Future Schools, and funding provision for schools involved in innovation and in producing digital content (Kong et al., 2014; UNICEF, 2018). The 2009-2014 "Strengthening and scaling technology" plan involved school leadership workshops and also training mentors for each school to support teacher colleagues in using ICT in curriculum, pedagogy and assessment. A key focus was about deepening teacher understanding of ICT pedagogy towards students being self-directed learners. Master plan 4 has involved further infrastructure provision according to the developmental stage of each school, encouraging supportive ICT facilities in homes and a future schools project in which particular contexts operate as trailblazers for other schools to build innovative practices so "quality learning is in the hands of every learner, empowered with technology" (UNICEF, 2018, p.4).

Table 1 summarizes the research relevant to various planning phases regarding key success factors for some developing countries concerning infrastructure, curriculum integration, student learning, teacher professional development, and school leadership. Beyond common success features such as provision of infrastructure, curriculum, e-textbooks, and teacher ICT workshops, as Table 1 indicates, many countries have additionally focused on school leadership and student ICT standards (Singapore, Malaysia, South Korea), with many of these countries and their system plans supporting teachers in working with peers to improve pedagogical practices involving ICT.

Table 1: ICT school success factors in developing countries

Country	Taiwan	Hong Kong	Singapore	S Korea	Malaysia
Infrastructure					
School computers, internet, wireless	●	●	●	●	●
Systems online learning digital platforms & curriculum resources	●	●	●	●	●
ICT related curriculum for schools	●	●	●	●	●
Curriculum integration					
Promoting ICT in curriculum delivery	●	●	●	●	●
Setting requirements for ICT integrated lessons		●	●	●	●
Developing e textbooks	●	●	●	●	●
Educational use of mobile technology	●	●			
Pedagogical use of ICT			●	●	●
Student learning					
Learning tasks regularly integrating e learning & personalized learning focus/21st century skills	●	●	●	●	●
Students use ICT standards, with teacher assessment tools outlined			●	●	●
Ethical ICT use focus	●	●		●	
Teacher professional development					
ICT technical skills & pedagogy training/workshops	●	●	●	●	●
ICT teacher standards		●		●	●
Teacher ICT peer mentorship & communities of practice		●	●	●	●
Leadership and capacity building					
Support school-based e learning programs including pilots for early adopters using ICT in subjects		●	●		●
Enhancing training for school leaders		●	●	●	●
Research centers for online learning	●				
Encouraging parents in home facilities to support online learning		●	●		

INDONESIAN ICT IN EDUCATION CONTEXT

Similar to all of these developing countries, Indonesia has been focusing on ICT in schools over a twenty-year period, with the initial planning focusing on curriculum materials, ICT networks, and online learning and distance education, as well as internet provision (UNESCO, 2013). A positive aspect of the plan was the involvement of various relevant government agencies including the Ministry of National Education of Indonesia (MoNE), National Education Standards Agency (BSNP), Indonesian National ICT Council (DeTIKNas), and Ministry of Communication and Information Technology (MCIT) (UNESCO, 2013). While the initial five-year plan involved public-private partnerships (e.g., Microsoft, Telecom) and various overseas donors (e.g., Japan, Australia, World Bank, Asian Development Bank), ICT integration in education has experienced ebb and flow. Specific programs have included educational TV, internet-based learning, electronic schoolbooks, block grants, provision of computer labs or single computers, and teacher training and master teacher processes (UNICEF, 2018). Initially ICT was taught as a separate subject but under the reviewed curriculum directions of *2013 Curriculum,* online learning was intended to be integrated across all subjects (Mahdum et al., 2019). Researchers have looked at the success of various ICT-related areas in Indonesian schools in specific locations, including aspects such as social media (Kristianto, 2017; Sumakul, 2013), mobile learning (Pramana, 2018; Sulisworo & Toifur, 2016), and teachers' professional development (Dewi et al., 2019; Owen et al., 2017; Sari, 2012).

These reports indicate that research into ICT and education is not new in Indonesia and that information about issues has been available for decision-makers. For example, issues hampering successful ICT implementation have been noted especially in relation to lack of infrastructure and teachers' technological competence (Mahdum et al., 2019). Despite about 20% of Indonesia's budget spent on education including ICT (Luschei, 2017), there has been a lack of ongoing coordinated planning. There are insufficient numbers of computers and other hardware, internet costs are high, and there are few resources for infrastructure maintenance and lack of electrification in some remote locations (Febriana et al., 2018; Mailizar & Fan, 2019; Prasojo et al., 2019). Furthermore, even when infrastructure is improved, teacher skills in integrating ICT into their classrooms has not been evident (Mahdum et al., 2019). These deficiencies have led to developing country comparative studies rating Indonesia for its ICT in schools as being at the 'implementing phase', while Singapore is rated as 'advanced phase' (UNESCO, 2013, p. 116). Furthermore, the lack of focus on training and support for the use of technology in the classroom and for student learning purposes, has been highlighted (Mahdum et al., 2019; Owen et al., 2017). Schools in urban areas have generally experienced fewer problems with ICT integration than those in rural areas, with particular issues existing for remotely-located schools (Azzahra, 2020; Owen et al., 2017).

Consistent with recent decades, ICT disparity between various geographic areas of Indonesia and impacts on student learning and life generally have become particularly evident during the global COVID pandemic in 2020. With schools closed, home isolation enforced, and high dependency on the internet for home schooling, "the uneven access to the Internet, the disparity in teacher qualifications and education quality, and the lack of ICT skills are becoming a vulnerability in Indonesia's distance learning initiative" (Azzahra, 2020, p.2). What is most significant is that home internet availability for the capital city of Jakarta is quite high at 89% and this statistic compares favorably with Bali at 74%, while home internet is only 53% in the more easterly province of Central Sulawesi. Meanwhile, Papua as the most westerly region of Indonesia, has the lowest access at only 29% (Azzahra, 2020). Given the recently completed undersea fiber-optic infrastructure of the 'Palapa Ring Project' which connects all Indonesian provinces, this is very concerning and there is a need for the Indonesian school system "to partner up with telecommunication and hardware providers to equip all schools, especially those in rural areas, with Internet connection, ICT facilities and skill development programs for teachers" (Azzahra, 2020, p. 6).

Some examples of positive ways forward for ICT in more remote location schools and communities which involve partnerships are already evident. South and Central Kalimantan regions have gained

successful ICT improvement through a mining company donor providing support with technology facilities, also provision of a series of workshops and seminars for teacher training, with some impacts evident on student learning (Jati et al., 2019).

Despite such ICT positive models in more remote locations, including through support from donor groups, there is a gap in research in terms of system-wide educational improvement processes. This current paper investigates some ICT aspects arising from a large scale, donor-supported program in schools in one of the most remote provinces of Indonesia, that being Papua (which abuts the Papua-New Guinea border). This is a location where little large-scale ICT research has previously occurred. This current research work is valuable for developing countries because it considers the issues for remote regions like Papua that are located within rapidly-progressing contexts like Indonesia, with the paper examining ICT in schools in relation to success factors that have been experienced by other developing countries and online learning operating at the systems education level.

THE PAPUAN EDUCATION CONTEXT

Papua in Eastern Indonesia is a province of about 3 million people, with the majority of the population living in over 3000 villages spread throughout remote lowlands and highlands, swamps and coastal areas. Papua province generally has few roads and minimal electrification and telecommunications infrastructure, especially in remote locations (Owen et al., 2017). Papua has high rates of poverty, illiteracy, and school non-retention, with 25% of children aged 7-12 years not enrolled (Anderson, 2013; UNICEF, 2019).

Student achievement is low. Illiteracy in Papua is 37% compared to 8% generally for Indonesia and with illiteracy in the most remote Papuan locations in the highlands being over 90% (UNICEF, 2019). Additionally, Papua is among the provinces with the lowest success rates in national school examinations, with student scores in international tests such as PISA being 10% lower than the Indonesian national average (Chang et al., 2014). Student achievement results are even lower in rural and remote Papua compared to its more urbanized areas, with only 15% of students in these areas being categorized as readers and with only about 5% of them reading with comprehension (UNICEF, 2017).

Poor teacher training, absenteeism, and morale, also low pay and lack of subject knowledge, are key aspects in Papua's lower student learning outcomes (Allen et al., 2018; Chang et al., 2014). Teacher non-attendance at schools and low-level qualifications are other issues which impede quality education to a greater degree in Papua than in other parts of Indonesia (Allen et al., 2018; McKenzie et alk., 2014; Sparrow & Vothknecht, 2011; UNICEF, 2019).

With student enrolment of around 350,000 in primary schools and 100, 000 in junior secondary (Indonesian Central Statistics Agency, as cited in Halim & Mononimbar, 2016), the Papuan education system employs over 13,000 teachers and consists of over 2600 schools at three levels (elementary SD, junior secondary SMP, and senior high SMA). Dropout rates are high, and many students repeat various year levels. There is a low rate of access to early childhood facilities (15%), as well as a low rate of student transfer from elementary schools to junior secondary schools (37.6%) (Modouw, 2011).

Student and teacher access to ICT is low, especially in remote locations; electricity and basic water supply services are lacking in these isolated communities generally. In past decades, the electrification rate, initially being accelerated, became stalled at around only 30% (Asian Development Bank, 2016), but there are promises of renewable energy for all remote villages by 2020 (Prakaso, 2019; UNICEF, 2019). Remote schools and communities have traditionally relied on low-capacity solar cells provided by local power providers or use generators for night-time lighting (Owen et al., 2017; Sparrow & Vothknecht, 2011). Close to 78% of primary schools and 8% of secondary schools are in remote coastal or highland locations, with the lack of power making education challenging especially given that ICT is increasingly playing a role in the education context (Sparrow & Vothknecht, 2011;

UNICEF, 2020). Despite a new internet fibre-optic 'Palapa ring' provision in recent years and also gradual availability of more solar power (Prakaso, 2019; UNICEF, 2019), infrastructure improvements which are intended to benefit remote Indonesian regions, a particular issue continues to be the use of the internet in Papua (UNICEF, 2020). Given increasing focus world-wide on online learning from home, only 29% of children have home internet access and even lower access rates are evident for the most remote Papuan locations. Teacher skills and ICT hardware, as well as poor internet provision and entrenched attitudes towards teacher-centred approaches, are issues generally in Papuan schools, and especially in the most remote places (Allen et al., 2018; UNICEF 2019).

PLANNING FOR ONLINE-LEARNING IN PAPUAN SCHOOLS

To improve education in Papua, a vision and plan for the educational integration of online learning, underpinned by pedagogical change, was documented and promoted in 2010, with support from an international donor group (World Bank, 2010). In this vision and plan, cluster-based ICT centres were established to provide digital learning lessons and professional development across schools. For more remote locations, the educational strategy also included establishing small elementary schools within community learning centers and the provision of quality television programs (World Bank, 2010).

The *ICT in Education Strategy and Implementation Plan for Education in Papua* (World Bank, 2010) took account of the special challenges confronting online learning in education in Papua, and it included teacher professional development and digital learning resources. There was considerable financial support from donor groups and from the Papuan education department and government. Three secondary school ICT centers were planned for each of the 20 districts operating at that time, with these sixty ICT centers being intended to be the focus for teacher professional development (Owen et al., 2017 World Bank, 2010). Each ICT center was to be allocated up to twenty laptops, a computer server, and a satellite terminal. In addition, a learning resource center was planned for teacher training and provision of high-speed copying and a small video facility was intended (World Bank, 2010). Secondary and middle schools not selected for ICT centers were to be allocated "minilabs," with the provision of ten computers and connection to a satellite or a fiber-optic network. Remote basic primary schools were to receive an "ICT station" comprising one laptop, internet connectivity, solar electricity and power storage. Schools were also encouraged to acquire computers for administration, and for integration with teaching and learning.

District-based programs were also established in ICT centers to provide internet access for the regional office and schools and to provide specific district-based programs. For example, in one district there was a Teacher Open Lesson program operating in partnership with a university. The ICT center in this district provided distance learning professional development in mathematics and science for primary school teachers, following a model that was also intended for use in other districts (Owen et al., 2017; World Bank, 2010).

The online learning program planning in Papua also included development of a teacher competency framework which was adapted from an ICT skills UNESCO framework. The framework included four competency levels: technology literacy (basic use of software, multimedia, internet, and ICT for administration), knowledge deepening (using software, communications, multimedia for mastery of subjects and in varied contexts), knowledge creativity (facilitating student learning and creativity using ICT), and knowledge sharing (sharing multimedia and learning resources, building a network of professionals) (Ministry of Education and Culture [MoEC], 2012). Foundational to the competencies and overall online learning program, and consistent with the literature, was the notion that principals and teachers need to have positive attitudes towards the integration of ICT into classroom practices that would have benefits for student learning (Korumaz, 2016; Prasojo et al., 2019; Prestridge, 2012).

The impact of the ICT strategic plan, the provision of ICT centers, and implementation of the professional development plan on Papuan education had not previously been investigated. An evaluation

was then conducted. A paper examining issues arising from the large-scale Papuan ICT study as relevant to professional development, has been published (Owen et al., 2017). This current article also presents some aspects of that larger study and some additional research which was undertaken. The current paper examines some aspects of a large-scale research project undertaken with foreign aid support in schools in Papua Indonesia. Research questions are: What are the attitudes to online learning of teachers and principals in Papuan schools? What ICT access and use occurs in Papuan schools? What improvements are needed to ensure successful online learning integration in Papuan schools? This article provides new information relevant to economically-emergent Asian locations in terms of remote schools by considering the topic areas and issues arising within the context of the literature about successful approaches to planning and implementation of ICT in schools in developing countries.

METHOD

This article reports on research undertaken using mixed methods including a survey of teachers and principals and principal interviews. Mixed methods, including surveys, enable breadth and rigor, but also, through using interviews, richness of data is obtained (Creswell, 2003; Denzin & Lincoln, 2005; Miles & Huberman, 1994). Mixed methods measure specific constructs and can be used to make group comparisons and to examine the strength of associations between variables of interest (Creswell, 2004). The survey field study has particular advantages such as being self-administered (Sekaran & Bougie, 2013) and also improving generalizing of findings (Scandura & Williams, 2000). Additionally, there are high levels of accuracy, with the survey instrument designed for the purpose of closely addressing the research questions (Slater, 1995).

THE SAMPLE

The sample design involved a three-stage stratified sample design being implemented following consultation and considering local contexts. In the first stage, using information about schools obtained from the Ministry of Education and Culture (MoEC), a sampling frame was constructed. This frame considered various identifiers about the school and whether it was provided with ICT program materials. Regencies representative of geographic and topographic districts were identified, with the four paired regencies eventually being selected after consultation with local education authorities.

In the second stage, the cost of reaching various types of districts and safety of various areas was considered, with easier to reach and safer locations being over-represented in the sample.

The final stage involved selection of specific schools. The sample included SD (primary) and SMP (junior secondary) schools in about equal proportions and similarly sought approximately equal numbers of public and private schools, thereby reflecting the population of Papuan schools as a whole.

The final stage of sampling involved establishing the sample of teachers and students within schools. Upon arrival in the school to commence the survey, enumerators undertook a random sample of 15 teachers in each of the schools using the staff roster (of those present at school on the day) and using a random sampling table according to total numbers of teachers to develop the sample.

Two hundred and twenty principals and 1505 teachers from 220 schools in eight sub-districts were in the stratified representative sample, with 107 elementary schools and 113 junior secondary schools involved. One hundred and ten schools were urban, 67 schools were outside urban areas and 43 schools were remote. As Table 2 indicates, about 60% of the teachers and 80% of the principals surveyed were male in the elementary and junior secondary schools, with most principals and teachers being aged 45–64 years (apart from Junior Secondary teachers whose predominant age was 34-44 years). Familiarity with ICT for teaching and learning by principals and teachers was recent, generally only for less than twelve months at the time of the survey.

Table 2: Survey respondent backgrounds

	Elementary	Junior Sec		Elementary	Junior Sec
Principal Male	81.5%	81.2%	Teacher Male	61.5%	58.3%
Principal Female	18.5%	18.8%	Teacher Female	38.5%	41.7%
Principal predominant age group	45-64	45-64	Teacher predominant age	45-64	34-44
Principal with bachelor degree	65%	67%	Teacher with bachelor degree	55%	85%
Predominant number of years of principals using ICT for admin	0	4-6	Predominant number of years of teachers using ICT for admin	0	0
Predominant number of years of principals using ICT for teaching and learning	0	0	Predominant number of years of teachers using ICT for teaching and learning	0	0

Leaders from 13 schools from various sub-districts were also interviewed, with six being from elementary schools and seven principals being from junior secondary schools.

THE INSTRUMENTS

Survey questions were devised specifically for this research work according to the evaluation key questions, with a pilot then conducted of the survey with a few principals and teachers. Consistent with Cronbach (1990), to check reliability of the mostly Likert scale questions, sample data arising from the pilot phase survey responses from principals and teachers were tested with Cronbach's alpha test and using SPSS. The internal consistency of reliability of the questions was mostly rated at a good level of 0.80, with several individual items being higher than 0.80. In terms of considering validity and the extent the survey tool was appropriate and "measures what it is intended to measure" (Carmines & Zeller, 1979, p. 17), construct validity testing was conducted using SPSS and Pearson's correlation. Correlation between each item questionnaire score with the total score, showed validity being significant at $<= 0.05$. After the pilot, survey modifications and additions occurred based on the results in the field trial.

The finalized version of the survey was given to teachers and principals in elementary and junior secondary schools. (Appendix A provides relevant questions). Questions were asked about ICT equipment and activity at school, frequency of use of ICT at school, and attitudes towards using ICT. Questions were generally asked using a five-point Likert scale (strongly agree, agree, neutral, disagree, strongly disagree). There were also questions about whether particular equipment was used at school or at home or other locations outside school using yes/no responses.

Regarding beliefs about ICT's value for learning, responses ('strongly agree' ,'agree', 'neutral', 'disagree',' strongly disagree') about teacher and principal attitudes were sought to aspects such as "I think computers help students to work collaboratively" or "I think computers are a necessary tool for learning." In relation to attitudes towards using ICT, questions were asked about whether ICT helps students to develop creativity, work collaboratively, and develop good communication skills; whether learning with computers is fun; and whether ICT is good for learning.

Regarding ICT use, questions were asked about the use of computers, laptops, tablets, digital cameras, and the internet. Relating to their main use of ICT at school, respondents were asked to reply yes/no about whether ICT was used for activities such as presentations, email, internet research, assessment and reporting to parents, class attendance, social networking with colleagues, or for supporting curriculum outcomes purposes. Other questions were about the frequency of use of specific types of ICT at school or at home or other locations outside school, ranging from "daily," to "2–3 times a week," "monthly," "not very often," or "never." There were some free response questions. They were also asked to respond yes/no about their use of ICT at home and for what purposes including aspects such as online purchases, preparing school materials, reading news bulletins, playing online games, searching for information, and any other purposes. Additionally, principals and teachers rated themselves in terms of their computer skills as "very capable", "capable", "not at all capable" or "I do not like using computers" and provided responses about help needed for them to become more capable users of ICT.

Relevant to supports and barriers for ICT and improvements needed, respondents were asked to comment (yes/no/don't know) regarding aspects such as professional development, ICT access for students, classrooms with computer availability, or reliable internet access. Specific questions about professional development for various types of ICT (e.g., relevant to resources provided on internet, school PD initiatives, educational TV) were also asked in terms of usefulness (to a great degree, some degree, not at all, don't know), including whether the professional development was relevant to leader or teacher skills improvement linked to student learning

Follow-up interviews were conducted with 13 selected school principals. The interview questions were open-ended, relating to teaching and learning and other activities using ICT, equipment, training and also any ICT improvements needed (Appendix B).

THE PROCESS

Up to fifteen teachers from each school were randomly selected from those in attendance on the survey day, with researchers providing information and seeking consent with appropriate forms signed. Fifteen hundred and five teachers did the survey and 220 principals. To provide wider information, using a convenience sample, an additional 13 school leaders were also interviewed by telephone about their experience of ICT training and ICT integration in schools. The interviews were digitally recorded and summary notes were also written.

METHOD OF ANALYSIS

Upon receipt of the completed surveys, a specially prepared data collation tool was used. SPSS was then utilized for more detailed analysis of key questions. In the data analysis process, the specially devised data collation tool was enhanced to provide more detailed information for specific categories of survey respondents, including by location for some questions. Pearson's correlation analysis was initially undertaken although this indicated no meaningful information, with the current paper presenting data using descriptive statistical processes. The descriptive statistics used in this analysis are graphical description and crosstabulation among the variables.

The qualitative analysis for the interviews involved examining summary updates of each interview and transcribing selected comments from the digital recordings, with manual coding to identify key themes being undertaken.

FINDINGS

The findings regarding attitudes to ICT, access and ICT use in schools and improvements needed appear below, reflecting key relevant messages emerging from the surveys and school principal interviews.

PRINCIPALS' AND TEACHERS' ATTITUDES

Relating to the first research question about ICT attitudes, almost without exception, principals and teachers regarded the integration of computers in schools for administration and teaching as very important, even when they themselves had no knowledge of how to use computers:

> Actually, it is very important but many of us do not know about it. So, we need to learn about it. If we do not learn about ICT, we will be left behind. We can input data for admin matters and from the internet we can see new ideas for teaching and learning. (Interviewee 11)

This positive attitude was highly evident in the survey of teachers and principals, as shown in Table 3.

Table 3. Beliefs about ICT's value for learning

	PRINCIPALS N=220		TEACHERS N=1505	
	STRONGLY AGREE %	AGREE %	STRONGLY AGREE %	AGREE %
I think computers help students to work collaboratively.	34.1	54.1	35.2	54.9
I think computers allow students to develop good communication skills.	36.8	54.5	41.2	50.8
I think using ICT develops creativity in students.	44.1	50.0	46.7	48.6
I think computers are a necessary tool for learning.	58.9	37.0	45.5	48.3

Table 3 indicates teachers' and principals' beliefs about the importance of computers in building communication skills, supporting students in developing communication skills, helping learning, and developing creativity, with over 95% positive responses for each aspect.

However, the interviews did signal some caution about computers. For example, one interviewee stated: "They [the students] need to be accompanied when they access the internet. We need to tell the parents first" (Interviewee 13). In the practical day-to-day activities of a busy school, the idea of teachers having to accompany students each time they access the internet could become a major impediment, particularly as many schools access the internet through a dial-up modem.

Overall, the attitude of principals and teachers to the use of computers in schools is very positive. There was also recognition of many barriers such as the lack of availability of computers, little access to computer training, poor internet access, and a lack of overall professional development opportunities for learning about integrating ICT in the classroom for student learning.

ICT ACCESS AND USE IN PAPUAN SCHOOLS

Relevant to the second research question concerning ICT access and use, only a few schools had significant access. Of 104 principal survey responses, about 25% had no computers or laptops in their schools. About 50% of schools had only one or two laptops and about 30% had only one or two desktop computers. Teachers and students reported that student use of computers in classrooms was almost non-existent, apart from schools that had computer laboratories, with 75% of teachers reporting that they did not use computers at school.

This information supports the finding that teachers mostly used computers in the classroom for school administrative purposes. A small number of computer labs were found in junior and senior

secondary schools in the higher population centers such as Jayapura, Keroom, Merauke, and Nabire. In those schools where a computer lab did exist, about 65% of principals and 75% of teachers indicated the importance of this access, considering computer labs of greater importance than other ICT such as classroom ICT access for various subjects using laptops.

However, a number of other barriers exist to the successful integration of computers in schools in Papua. There was only 30% electrification at the time of the research in Papua, with instability of power in urban areas being among issues highlighted (ACDP, 2014). Even when the supply of computers is satisfactory, training in how to use them often does not follow. As an interviewee said:

> We once were supported with computers from Australia and wi-fi. However, they only gave us computers without any training on how to use them in classrooms. So, we only used them for typing. Recently, we have just received 12 computers but we have not opened them because we do not know how to use them. (Interviewee 1)

The main use of computers for 60% of principals and 40% of teachers was for administration, including use of ICT for tasks such as test writing and report writing.

In terms of frequency of ICT use, Word documents were used weekly/2–3 times a week for about 40% of teachers and principals, with about 28% of teachers and 15% of principals using spreadsheets and PowerPoint at a similar rate of regularity.

Many principals and teachers who did integrate computers in classrooms said that the software programs they used in their work were MS Word, MS Excel, and MS PowerPoint. They used these for recording attendance and for supporting students in the curriculum and presentations, as Table 4 indicates:

Table 4 Percentage of cohort using ICT for specified purposes

ICT USAGE	TEACHERS N=1500	PRINCIPALS N=219
Presentations	50.4%	54.8%
Email	29.1%	45.0%
Internet research	24.4%	23.0%
Assessment and reporting to parents	54.2%	63.3%
Class attendance	72.5%	69.1%
Social networking with colleagues	51.2%	32.7%
Supporting students to achieve the outcomes required for Curriculum 2013	70.5%	69.6%

Support for students with the curriculum often meant presentations in classrooms using a laptop, sometimes with an LCD or projector attached. As one interviewee said, "We use the computers for presentation in the classroom, and we can also work with Word and Excel" (Interviewee 8).

Given lack of access and ICT use in many schools, it is unsurprising that, as Table 5 indicates, high numbers of principals and teachers did not consider themselves to be "computer literate," with 75% of principals and 41.5% of teachers indicating that they were "not at all capable."

Table 5. Principal and teacher self-rating about computer skills

	VERY CAPABLE %	CAPABLE %	NOT AT ALL CAPABLE %
Principals	3.2	20.9	75.0
Teachers	9.4	47.9	41.5

Of interest are the regional differences, with about 75% of principals in the more urban areas of Papua rating themselves as "not at all capable" and over 80% of the most remote principals. For teachers, around 38% from urban areas/50% from remote areas rated themselves as "not at all capable".

Many who were proficient with computers appeared to have learnt how to use them by themselves and sometimes they were owners of a laptop. As one principal interviewee indicated, "I can use computers. I learned by myself. I use my own laptop … for writing reports and teaching in the classroom" (Interviewee 2). Another said about using computers: "They [teachers] don't have to write anything on the board" (Interviewee 2), giving an indication that teachers' preparation of lessons could be made easier by using computers.

The surveys and interviews with principals suggest that professional development for principals and teachers in computer skills and associated pedagogical practices in using ICT in the classroom are essential if digital technology is to be integrated within Papuan classrooms. ICT centers have been established in four regions with a focus on ICT and professional development (ACDP, 2014). Six ICT centers have been established and consist of "lead" schools and connected schools with 60 schools in the program. However, their establishment has been slow because of hardware and infrastructure issues (ACDP, 2014). Programs such as those involving distance education and teacher education in digital technologies have been conducted in these centers, and principals and teachers in nearby areas have benefited.

Despite these centers being available to support professional development in some locations, there remains a large gap in ICT skills among principals and teachers, particularly when one considers that teachers are subject to Indonesia's ICT Competency Framework for Teachers (MoEC, 2012). As one principal said in relation to ICT skills, "And for teachers, it is … important because now in Indonesia we have Teacher Competence Test, which is an online-based test" (Interviewee 9).

In summary, the teacher and principal surveys and the follow-up principal interviews indicate that progress in ICT is being made, especially in the more populous coastal areas and in both junior secondary and senior secondary schools. However, unreliable power supplies and internet connections, together with lack of computer access for teachers and students remain issues, as does professional learning for teachers, especially in primary schools.

An interesting paradox here is that mobile phones are a dominant feature of telecommunications, with over 1 million users in Papua (World Bank, 2010). Over 70% of principals and teachers responded in the survey that they own handphones. About 30% of principals and 39% of teachers indicated use of smartphones, with about 15% student smartphone use, and with smartphone use for all survey respondents being higher in urban areas. Despite ownership of smartphones, there is little use in schools; hI do not allow cellphones at school. We have a strict rule and a good order here in our school related to students' use of cellphones. But if they want to use their cellphones, they can use it at home, but not at school" (Interviewee 12).

An observation is that the use of student cellphones which can access the internet in remote areas could potentially assist school students to have increased access to technology in schools, prior to the introduction of reliable power supplies and internet infrastructure in the future.

PERCEPTION OF IMPROVEMENTS REQUIRED

Principals and teachers do regard ICT in education as important for learning, administration, and lesson preparation but, relevant to the third research question about improvements, there needed to be more computing equipment and peripherals such as printers, together with a reliable power supply and internet connection.

Additionally, and significantly, beyond the supply of equipment and infrastructure, survey respondents and interviewees indicated that successful implementation of an ICT program requires improvements in opportunities for professional learning for principals and teachers. Principals said that they and their teachers wanted to be trained to use computers, as well as learning how to integrate ICT with learning in their classrooms. Generally, principals indicated that they considered professional development and equipment provision to be an education system responsibility, and they did not have ICT funds and purchase plans for their schools.

As one principal interviewee indicated:

> If we had computers in our school, I believe we could learn about how to use them. The problem is we don't have them. I also hope the government could give us training on how to use computers in the classroom. (Interviewee 5)

What these responses highlighted is that, despite training being identified in the ICT strategic plan (World Bank, 2010), this plan had not been comprehensively implemented by the ministry in the province, although training for administrative aspects was more evident. Survey respondents and principal interviewees identified the value of provincial- and district-level professional development, with some people also indicating the need for school-led professional learning, thereby reflecting previously outlined research about the significant role of the principal (Korumaz, 2016; Prasojo et al., 2019). Some schools, particularly junior and senior secondary schools in populous coastal areas, had benefited from having ICT centers and computer labs, although this was not widespread. As previously outlined, training centers have been a successful part of provision of ICT in other countries (Ham et al., 2006). Similarly, these central training centers within Papuan districts enable key school-based ICT personnel to be trained, and then these persons are provided with follow-up support as they train teachers in their own schools.

However, in general, few schools had professional learning plans and most principals did not see ICT training of teachers as their school's responsibility, instead viewing this as the responsibility of the government. As one principal indicated in terms of improvements needed, "If possible, please give special trainings [sic] for teachers on how to use computers in the classroom" (Interviewee 1). Teachers and principals overwhelmingly indicated the need for teachers to be supported to use ICT in their subjects across the curriculum as a way of improving pedagogy, to promote integration with the curriculum, and for the purpose of knowledge deepening, knowledge creation and enhancing 21st century skills needed by students.

DISCUSSION AND IMPLICATIONS

Addressing research gaps regarding donor-supported large-scale studies into whole-of-system ICT in education programs in remote locations within developing countries, surveys and interviews were undertaken in Papua, Indonesia. Research questions related to ICT attitudes, ICT access and use, and perceptions about improvements needed.

In both the surveys and interviews, relevant to questions about teacher and principal ICT positive attitudes, a high degree of optimism was evident about the benefits of online learning in education. Principals said that online learning was important to support themselves and the teachers in administration, preparation of lessons, and in accessing teaching and learning resources. Also, they highlighted that, in their view, online learning could benefit students if it could be integrated with the

classroom curriculum programs. Indeed, the Papuan responses are consistent with previously research that more professional development is needed relevant to online learning pedagogy (Korumaz, 2016; Mailizar & Fan, 2019; Mwendwa, 2017; Prasojo et al., 2019). Consistent with whole-of-system education system's ICT planning and implementation previously outlined as established in Singapore and Hong Kong (UNESCO, 2013), given Papuan remoteness, what is particularly important is ensuring that school-based and ongoing ICT professional learning for teachers occurs (Mwendwa, 2017). As evident from studies in developing country contexts like Kenya, Pakistan, and Tanzania (Ismail et al., 2020; Laaria, 2013) principals need to be trained as leaders of ICT, providing a positive context and developing a plan for teacher and student online learning access and competence. As previously outlined, a key aspect of planning, particularly in developing country contexts involving remoteness, is ensuring some staff have additional opportunities for training and high levels of ICT competence, with leaders then supporting these people to work as coaches with other staff (Ham et al., 2006; Ismail et al., 2020; Laaria, 2013; Lloyd et al., 2016).

Regarding the research question relating to ICT access and use, some principals indicated that they used computers themselves for school administrative purposes and to prepare lessons, with some teachers indicating that they use ICT to prepare lessons and for presentations in classrooms, often using an LCD screen. Reflecting previous studies discussed earlier from various developing countries (Azzahra, 2020; Karunaratne et al., 2018; UNICEF, 2019), in most instances in the current Papua study, schools had an unreliable connection to the internet except in some large population centers in coastal regions and there were few technology devices. Similar to studies in remote places such as Cambodia, Rwanda and Ethopia (Habibi et al., 2018; Kilinc et al., 2018; Prasojo et al., 2019), computers in Papua were rarely used by students in classrooms other than for presentations because the number of computers available in schools was universally minimal and usually restricted to one computer per school, especially in primary schools, with technical support and maintenance issues evident. However, principals and teachers in junior and senior secondary schools in more urban context had more access to computers and the internet, including some with computer labs and ICT centers. Interestingly, a number of principals and teachers in some more urban locations owned or had access to a connected mobile phone, as did many students. Despite this, mobile phones were not allowed in most schools and were not used for education.

Relevant to issues and improvements needed, a key issue raised previously, of broader relevance to government/funder partnerships regarding ICT in developing countries, was the importance of collaborative planning and decision making between these bodies, with decisions led by the key ministry persons. Additionally, to ensure sustainable innovation practices, ownership and professional capacity building need to be expanded to involve a wider group of stakeholders, including through ongoing communication of success stories during the implementation phase (Gillies, 2010; Passey et al., 2016; Riddell & Nino-Zarazua, 2016; Samoff et al., 2011). In Papua, the World Bank as a donor body had developed the strategy and implementation plan with involvement from key government persons (World Bank, 2010). Despite this plan, it seemed that there was insufficient agreement and clarity between the donor body and Papuan government authorities about the roles of various groups in carrying out the plan. Furthermore, echoing previously outlined research about the importance of collaborative donor programs focusing on improving student achievement rather than merely being concerned with administration (Riddell & Nino-Zarazua, 2016), there is little evidence of this strategic focus, particularly in the implementation phase within the Papuan ICT context.

Specifically, in relation to the third research question and professional learning aspects of the ICT plan and improvements needed at the system level, some of the relevant training in using ICT for administrative purposes had been implemented by Papuan key personnel. However, despite research indicating the importance of training in ICT which involves frequency of practice for teachers and time for a mindset shift from teacher-centered to student-centered learning (Allen et al., 2018; Danner, 2014; Harendita, 2013), it seemed that other essential ICT professional learning, such as in using ICT for curriculum purposes, did not occur. Given insufficient ICT training and use, teachers and

principals did not generally have high levels of technical skills on computers. Regarding the previously outlined framework on ICT teacher competencies (UNESCO, 2011), most teachers and principals could not be regarded as having skills beyond the "technology literacy" level. This level indicates only very basic ICT skills and use for curriculum and assessment or for administration, with little understanding and use of the potential of ICT for deepening student knowledge, higher order thinking or for creative purposes (Harendita, 2013; Mwendwa, 2017).

Considering whole-of-system ICT in education aspects, and Papua Indonesia and its ICT in school issues in relation to the system planning success factors identified in the research literature earlier in this paper (Riddell & Nino-Zarazua, 2016; UNESCO, 2013), all aspects of Papuan infrastructure, curriculum integration, student learning, teacher professional development, and school leadership need improvement. Indonesia did have an ICT plan and key government agencies and donor groups involved, but there have been issues in terms of implementation, particularly in Papua which is a significantly remote area of this country. As Table 1 indicated in regard to success factors, Indonesia, like other countries, needs to have sufficient ICT infrastructure such as computers, laptops, tablets, and mobile technologies, together with reliable power sources and internet and with sufficient resources to maintain the infrastructure properly. Additionally, the Indonesian plan did not focus sufficiently on ICT training in building teacher and principal skills in integrating online learning into the classroom for building student skills in creativity and problem-solving. Instead, Indonesia's focus was on teaching ICT skills in a technical way, rather than focusing on the use of ICT across the curriculum to support student learning (UNESCO, 2013).

Table 1 indicates that success for Singapore, Malaysia, South Korea, Hong Kong, and Taiwan has come from teacher training towards integrating online learning across all subjects, with Singapore, Korea, and Malaysia also establishing ICT standards for students at various year levels and in specific ICT skills areas (Kong et al., 2014; UNESCO, 2013). The goal for all of these countries has been working towards development of student skills for personalized learning. Therefore, successful teacher professional development has gone beyond one-off workshops in centralized locations. Professional development has been about ongoing school-based approaches, with teacher learning communities and school-based mentors involved so that each teacher is able to use technology in every classroom as part of quality pedagogical approaches (Kong et al., 2014). Another learning from these success contexts is about ensuring that school leaders have the skills to lead quality online learning in their schools. School leadership skill-building is particularly important for Papua as a remote location, with school leaders needing to establish key mentors and teacher peer learning groups, with a focus being on teachers using ICT in pedagogically-appropriate ways as relevant to their subjects so that students achieve competency for personalized learning.

A limitation of this research is that it occurred in one region within Indonesia at a particular point in time. Further research in this Papuan and in other isolated regions in Indonesia and in similar remote locations in developing countries and regions would be useful to update information about ICT infrastructure and professional learning success factors. This is especially the case in relation to situations where aid provision is supporting the ICT innovation work, for the purpose of highlighting successful government approaches involving collaborative partnerships.

CONCLUSION

Research was undertaken regarding a large-scale ICT initiative in schools in the remote Indonesian region of Papua, with the current paper focusing on ICT attitudes, access and use, and improvements needed. The findings highlight teachers' and school leaders' positive attitudes to ICT in education, although the results indicate that ICT was frequently applied for administrative purposes rather than for teaching and learning. Reflecting previous studies, principals and teachers highlighted some improvements that were needed including systematic training in computer skills and professional learning about the integration of ICT with teaching and learning, especially in relation to pedagogical practices (Mailizar & Fan, 2019; Mwendwa, 2017), as well as the need for improved infrastructure and

equipment (Azzaahra, 2020; Habibi et al., 2018). The paper draws on the literature about online learning and systems ICT planning and implementation approaches in developing countries (UNICEF, 2013), as well as foreign aid research strategies, with the purpose of highlighting some possible success directions for remote locations, an under-researched area.

The study makes a significant contribution to the literature by highlighting issues and potential success factors as evident in remote regions of developing countries that have achieved recognition for widescale ICT implementation in schools. This includes issues in relation to policy makers and education authorities working with foreign aid funders. Supporting other studies from various developing country contexts (Laaria, 2013; Prasojo et al., 2019; UNICEF, 2013), of significant importance is the need for coordinated and collaborative strategic planning with donors and partners, including in relation to sustained professional learning towards student-oriented ICT pedagogies, with school leaders upskilled to lead establishment of a positive student-centered culture and peer coaching context. Particularly relevant to developing countries in remote locations is the importance of additionally addressing specific infrastructure needs, teacher training and maintenance issues.

Given the limitations of this research at a particular point in time and continually changing contexts with ICT and its use for student learning, more research is needed in developing countries and, in particular, in more remote locations including in Papua. There are specific issues for such places which differ from those encountered in capital cities which warrant further investigation

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APPENDIX A. EVALUATION OF ICT IN EDUCATION IN PAPUA PROVINCE

PRINCIPAL SURVEY: SELECTED QUESTIONS

1. Types of ICT Programs

The following questions relate to the types of ICT programs that may be available at your school. Please tell us if they are available for use.

Please **tick one box** in each row.

		Yes	No	Don't know
1.	TV-Edukasi (resources and teacher professional development)	☐	☐	☐
2.	Portal Rumah Belajar (online resources)	☐	☐	☐
3.	SEA-EduNet (online learning resources)	☐	☐	☐
4.	School Net	☐	☐	☐
5.	Jardiknas (Indonesian education ICT network)	☐	☐	☐
6.	ICT Centres and ICT Mini-labs	☐	☐	☐
7.	School-based ICT initiatives	☐	☐	☐
8.	University supported ICT programs	☐	☐	☐
		☐	☐	☐

9. Yayasan supported ICT programs

10. What other ICT programs does your school use?

3. Use of ICT Programs

The following questions are about how often **you** *use these resources. Please* **tick one box in each row** *to indicate your answer*

	One or more times each day	*2–3 times a week*	*About once a week*	*About once a month*	*Never*
1. TV-Edukasi (resources and teacher professional development)	☐	☐	☐	☐	☐
2. Portal Rumah Belajar (online resources)	☐	☐	☐	☐	☐
3. SEA-EduNet (online learning resources)	☐	☐	☐	☐	☐
4 SchoolNet	☐	☐	☐	☐	☐
5. Jardiknas (Indonesian education ICT network)	☐	☐	☐	☐	☐
6. ICT Centres and ICT Mini-labs	☐	☐	☐	☐	☐

7.   Have you ever seen the CDs and DVDs provided by Pustekkom?

	Yes	*No*	*Don't know*
	☐	☐	☐

*For the questions below, please **tick one box** in each row to indicate your answer*

	Yes	*No*
8. Do you use the CDs and DVDs provided by Pustek-kom?	☐	☐

	Very useful	*Sometimes useful*	*Not useful at all*	*Don't know*
9. How useful are the CDs and DVDs provided by Pustekkom?	☐	☐	☐	☐

4.   Usefulness of ICT Programs

IF YOU ANSWERED **"NO"** OR **"DON'T KNOW"** TO **ALL** OF **QUESTION 2, <u>GO DI-RECTLY TO QUESTION 6</u>**

You have indicated that one or more ICT programs operate in your school. If you use the programs listed below, what are the most watched or most used parts? **If you don't use these resources, go to the questions on the next page.**

1.   TV-Edukasi (resources and teacher professional development)

2.   Portal Rumah Belajar (online resources)

3.   SchoolNet (online learning resources)

The following questions are about the usefulness of the ICT programs in supporting classroom practice.

Please **tick one box** *in each row to show your answer.*

	Very Useful	Useful	Not useful at all	Not applicable to my school
4. TV-Edukasi (resources and teacher professional development)	☐	☐	☐	☐
5. Portal Rumah Belajar (online resources)	☐	☐	☐	☐
6. SEA-Edu Net	☐	☐	☐	☐
7. School Net	☐	☐	☐	☐
8. Jardiknas (Indonesian education ICT network)	☐	☐	☐	☐
9. ICT Centres and ICT Mini-labs (including Teacher Professional Development)	☐	☐	☐	☐
10. School-based ICT initiatives	☐	☐	☐	☐
11. University supported ICT programs	☐	☐	☐	☐
12. Yayasan supported ICT programs	☐	☐	☐	☐

13. If applicable, please outline how you use one of the programs above.

14. How does this program contribute to your learning?

15. How does this program contribute to the learning of your students?

5. Usefulness of ICT Professional Development

The following questions ask you about the "usefulness" of the professional development programs provided for a range of ICT programs.

Please **tick one box** *in each row to indicate the usefulness of the professional development in supporting classroom practice.*

		Very useful	*Useful*	*Not useful at all*	*Resource available but no professional development was provided*	*Resource not available so not applicable in my school*
1.	TV-Edukasi (resources and teacher professional development)	☐	☐	☐	☐	☐
2.	Portal Rumah Belajar (online resources)	☐	☐	☐	☐	☐
3.	SEA-EduNet (online learning resources)	☐	☐	☐	☐	☐
4.	School Net	☐	☐	☐	☐	☐

5.   Jardiknas (Indonesian education ICT network)

☐ ☐ ☐ ☐ ☐

6.   ICT Centres and ICT Mini-labs

☐ ☐ ☐ ☐ ☐

7.   School-based ICT initiatives

☐ ☐ ☐ ☐ ☐

8.   University supported ICT programs

☐ ☐ ☐ ☐ ☐

9.   Yayasan supported ICT programs

☐ ☐ ☐ ☐ ☐

10.   To what extent has the TVE professional development program been successful in improving your leadership skills in using ICT for student learning?

To a great degree	*To some degree*	*Not at all*	*Don't know*
☐	☐	☐	☐

11.   To what extent has the TVE professional development program been successful in generally improving the skills of your teachers in using ICT for student learning?

To a great degree	*To some degree*	*Not at all*	*Don't know*
☐	☐	☐	☐

ALL SURVEY PARTICIPANTS SHOULD COMPLETE ALL OF THE QUESTIONS TO THE END OF THE SURVEY

6. Attitude Towards Using ICT

This section provides questions to collect information about your own attitudes about using ICTs. Please **tick one box** *in each row to show your answer.*

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1. I think that learning with computers is fun.	☐	☐	☐	☐	☐
2. I think that computers are difficult to understand.	☐	☐	☐	☐	☐
3. I think computers are a necessary tool for learning.	☐	☐	☐	☐	☐
4. I think it is important to know how to use a computer.	☐	☐	☐	☐	☐
5. I think computers help students to work collaboratively.	☐	☐	☐	☐	☐
6. I think computers allow students to develop good communication skills.	☐	☐	☐	☐	☐
7. I need to know more about ICT before my students can use it.	☐	☐	☐	☐	☐
8. I think using ICT develops creativity in students.	☐	☐	☐	☐	☐

9. Computers help me to learn new things.

☐ ☐ ☐ ☐ ☐

10. Working with ICT makes me nervous.

☐ ☐ ☐ ☐ ☐

11. I think using a computer is frustrating.

☐ ☐ ☐ ☐ ☐

9.   ICT Planning

These questions are about planning for ICT in your school.

	Yes	No	Don't know
1. Does your school have its own ICT hardware purchasing program?	☐	☐	☐
2. Does your school have an ICT Plan?	☐	☐	☐

IF YOUR SCHOOL HAS AN ICT PLAN, please answer these questions. If not, go to QUESTION 10.

*Please **tick one box** in each row.*

	Yes	No	Don't know
3. Is the school ICT plan clearly expressed in the RKAS?	☐	☐	☐
4. Is the school ICT plan understood by all staff?	☐	☐	☐
5. Does the school ICT plan consider the needs of all students?	☐	☐	☐

10. Support and Barriers to ICT Use

These questions are about supports and challenges involved in ICT use. Are the following aspects important to enable you and your staff to use ICT in your teaching and learning?

*Please **tick one box** in each row regarding whether you believe the aspects are a support for ICT use.*

	Yes	*No*	*Don't know*
1. Opportunities for ICT professional development for teachers	☐	☐	☐
2. Access to a computer lab in working order for use by students	☐	☐	☐
3. A classroom with sets of computers	☐	☐	☐
4. Reliable internet access	☐	☐	☐

11. Capability in Using ICT

*This section asks you to evaluate **your own skills** in using ICT*

	Very capable	*Capable*	*Not very Capable*	*I do not like using ICT*
1. How capable do you think you are in the use of ICT?	☐	☐	☐	☐

2. What help would you like to become a more capable user of ICT?

12. ICT Equipment and Activities at School

These questions are to tell us about what is available to you and your students for use at school. Place a tick in each column, one tick for teachers ("yes" or "no" or "don't know") and one for students ("yes" or "no" or "don't know" (i.e. two ticks per row).

		Teacher			Student		
		Yes	No	Don't know	Yes	No	Don't know
1.	Computer	☐	☐	☐	☐	☐	☐
2.	Laptop	☐	☐	☐	☐	☐	☐
3.	Tablet	☐	☐	☐	☐	☐	☐
4.	Printer	☐	☐	☐	☐	☐	☐
5.	LCD/Infocus	☐	☐	☐	☐	☐	☐
6.	Digital camera	☐	☐	☐	☐	☐	☐
7.	Smart phone (handphone with camera and internet connection)	☐	☐	☐	☐	☐	☐
8.	Hand phone	☐	☐	☐	☐	☐	☐
9.	Television	☐	☐	☐	☐	☐	☐
10.	DVD player	☐	☐	☐	☐	☐	☐
11.	Photocopier	☐	☐	☐	☐	☐	☐
12.	Social media (e.g. Facebook)	☐	☐	☐	☐	☐	☐
13.	Email	☐	☐	☐	☐	☐	☐
14.	School website	☐	☐	☐	☐	☐	☐

15. Internet ☐ ☐ ☐ ☐ ☐ ☐

16. Text messaging ☐ ☐ ☐ ☐ ☐ ☐

13. Frequency of Use of ICT at School

	One or more times each day	2-3 times a week	About once a week	About monthly	Never
1. Computer	☐	☐	☐	☐	☐
2. Laptop	☐	☐	☐	☐	☐
3. Tablet	☐	☐	☐	☐	☐
4. Printer	☐	☐	☐	☐	☐
5. LCD/Infocus	☐	☐	☐	☐	☐
6. Digital camera	☐	☐	☐	☐	☐
7. Smart phone (handphone with camera and internet connection)	☐	☐		☐	☐
8. Hand phone	☐	☐	☐	☐	☐
9. Television	☐	☐	☐	☐	☐
10. DVD player	☐	☐	☐	☐	☐
11. Photocopier	☐	☐	☐	☐	☐
12. Social media, e.g. Facebook	☐	☐	☐	☐	☐

13. Email

14. School website

15. Internet

16 Text messaging

14.   School Policies

These questions ask about what the policies are in the school about using Facebook and social media, smartphones and text messaging and how these policies impact on using ICT in the classroom.

		Yes	No	I don't know
1.	Does the school have a policy about the use of social media (e.g. Facebook)?			
2.	Is this policy a support or a barrier to using ICT in the classroom?			
3.	Does the school have a policy about the use of smartphones?			
4.				
5.	Is this smartphones policy a support or a barrier to using ICT in the classroom?			
6.	Does the school have a policy about the use of text messaging?			
7.				
8.	Is this text messaging policy a support or a barrier to using ICT in the classroom?			

15. Specific Use of ICT at School

These questions are about your specific use of ICT in your work at school. Please tick yes or no in each row.

		Yes	*No*
1.	Presentations	☐	☐
2.	Email	☐	☐
3.	Internet research	☐	☐
4.	Assessment and reporting to parents	☐	☐
5.	Class attendance	☐	☐
6.	Social networking with colleagues	☐	☐
7.	Supporting students to achieve the outcomes required for Curriculum 2013	☐	☐

8. If applicable, please list other things **you** do with ICT at school.

16. Frequency of Use of ICT Software at School

These questions are about how frequently you use ICT in your work at school. Please tick one box in each row

	One or more times daily	*2–3 times a week*	*About once a week*	*About once a month*	*Never*
1. Spreadsheet	☐	☐	☐	☐	☐
2. Word documents	☐	☐	☐	☐	☐
3. Picture or graphic software	☐	☐	☐	☐	☐
4. PowerPoint	☐	☐	☐	☐	☐
5. Desktop Publisher	☐	☐	☐	☐	☐

6. If you use any other software packages, please add them below and indicate how frequently you use them.

17. Use of ICT at Home

*The following questions are about **your own use of ICT at home or outside of school** in another location. Please tick one box in each row.*

	Yes	No
1. Computer	☐	☐
2. Laptop	☐	☐
3. Tablet	☐	☐
4. Printer/s	☐	☐
5. LCD/Infocus	☐	☐
6. Digital camera	☐	☐
7. Smartphone	☐	☐
8. DVD player	☐	☐
9. Photocopier	☐	☐
10 Text messaging	☐	☐
11 Social media (e.g. Facebook)	☐	☐
12 Email	☐	☐

Do you use the Internet at home for any of the following purposes? *(answer **yes** or **no** for each item)*		
	Yes	*No*
13. Online purchasing	☐	☐
14. Preparing school materials	☐	☐
15. Reading news bulletins	☐	☐
16. Playing online games	☐	☐
17. Searching for information	☐	☐
18. Any other purposes (please specify)		
19. If applicable, please list any other ICT that **you** use at home or outside of school in another location		

18.   Summary Questions

*Please **tick one box** in each row to show your answer.*

	To a great degree	*To some degree*	*Not at all*	*Don't know*
1. From your perspective, to what extent has infrastructure for ICT improved in the past four years?	☐	☐	☐	☐
2. From your perspective, to what extent has connectivity for ICT improved in the past four years?	☐	☐	☐	☐
3. From your perspective, to what extent has equipment for ICT improved in the past four years?	☐	☐	☐	☐
4. To what extent has ICT supported improved educational management?	☐	☐	☐	☐
5. To what extent has ICT supported improved educational reporting?	☐	☐	☐	☐
6. To what extent has ICT improved student access to education resources for learning?	☐	☐	☐	☐
7. To what extent has ICT improved teacher access to education resources for learning?	☐	☐	☐	☐

APPENDIX B. RELEVANT PRINCIPAL INTERVIEW QUESTIONS

What ICT equipment/other infrastructure (internet) is available in the school and who provides this?

In what ways do you and the teachers use computers in the classroom and at school and what software programs are available?

How did you learn to use computers?

What ICT training have you or your teachers and admin staff attended and what else is needed?

What is your attitude to online learning and its purposes?

What access do students have to online learning and what do they do on computers?

BIOGRAPHIES

Dr Susanne Owen has over 40 years' experience as a teacher, school leader and education department manager, also as educational researcher within tertiary institutions and a Principal Research Fellow. During the past decade, she has worked extensively in international development, including on long-term consultancy projects in Timor Leste, Tuvalu, Kiribati and in Papua (Indonesia). She has led large-scale teams in evaluation and school reform towards improving developing country education systems in sustainable ways. She has written over 20 research reports and book chapters and has over 50 research publications in school leadership, professional learning communities, workforce planning, Information technology and, also, in health workforce development and in law education. She is a member of Uni SA's Research in Educational and Social Inclusion group.

Dr Gerald White has worked in education for over fifty years as a teacher, consultant, lecturer, school Principal, education system head, CEO of the national Australian government education and training technology agency and a Principal Research Fellow. He is an expert in the use of digital technologies and media in education having led its introduction in Australian education and later as a researcher. He has an extensive list of publications and has spoken internationally for over twenty years on the uses and misuses of teaching and learning with digital technologies and media.

For over 27 years, **Dr. Dharmaputra Taludangga Palekahelu** has been experienced working in the education field. Besides being a lecturer in Satya Wacana Christian University, he is also a project director in the development of schools in remote areas of Papua and education consultant for the developing literacy program in Papua and East Nusa Tenggara, also the developing science and math teachers' capacity program in East Nusa Tenggara, Papua and North Celebes. Moreover, he also has published several types of research related to the use of ICT in learning.

Dian Toar Y. G. Sumakul is a lecturer and researcher at English Language Education Programme, Universitas Kristen Satya Wacana (UKSW). He is also a co-founder and board member of Indonesia Technology Enhanced Language Learning (iTELL). His research interest is primarily on educational technology and particularly on the use of digital technologies in language learning and teaching. He is also a teacher trainer and has been invited to deliver a number of talks and workshops at schools and universities in Indonesia

Eko Sediyono is a member of the IEEE Computer Society, Indonesia Chapter, with member number 41605422. He received his first degree in Statistics from Bogor Agricultural Institute, Bogor, Indonesia, in 1985. He achieved a Master's Degree in Computer Science from Indonesian University in 1994 and his Ph.D. from Computer Science Department of University of Indonesia in 2006. His research interest is in the statistics, data analytic, education technology, and information processing. He is now a professor at the Faculty of Information Technology - Satya Wacana Christian University Salatiga, Indonesia.