Institution: University of Northumbria at Newcastle

Unit of Assessment: 11 (Computer Science and Informatics)

Title of case study: DIGISTEM: Developing digital education skills in Ekiti State, Nigeria, and maintaining teaching through ICT during COVID-19 lockdown

Period when the underpinning research was undertaken: 2014 – 2020

Details of staff conducting the underpinning research from the submitting unit:

Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
Opeyemi Dele-Ajayi	Senior Research Fellow/Lecturer	01/09/2014 – present
Rebecca Strachan	Professor of Digital Technology and Education	01/09/2008 – present
Alison Pickard	Associate Professor	08/10/1996 – present
Jonathon Sanderson	Senior Lecturer	01/09/2014 – present
Emma Anderson	Senior Lecturer	22/07/2002 – present
Itoro Emembolu	Senior Research Assistant	31/10/2017 – present

Period when the claimed impact occurred: 2018 – 2020

Is this case study continued from a case study submitted in 2014? N

1. Summary of the impact (indicative maximum 100 words)

Ekiti is a state in Nigeria, with a population of around 2,200,000. Prior to 2015 there was no formal Information and Communications Technology (ICT) training delivered in Ekiti schools due to a lack of skills, low staff confidence, and insufficient digital infrastructure. Between 2018-2020, Northumbria University's DIGISTEM project (funded by the World Bank) designed and delivered interventions for digital skills training for teachers. In addition to reaching 3,745 teachers, thus significantly increasing access to ICT skills in state schools, this work directly led to a 30% increase in Science, Technology, Engineering, and Mathematics (STEM) subject enrolment in participating schools. Northumbria researchers also contributed to rapid response efforts in Ekiti State during the COVID-19 pandemic, helping to ensure that around 35,000 students remained engaged with learning activities during lockdown.

2. Underpinning research (indicative maximum 500 words)

In 2018, Nigeria's Ministry of Education stated in their '2018-2022 Education for Change: A Ministerial Strategic Plan' report that digital skills training in children's education was hampered by a range of structural problems. These included a lack of digital infrastructure and resources, the number of teachers with low digital skills and low confidence in using digital resources as educational tools, and low enrolment in STEM classes, especially among young women. The Ministry of Education identified these issues as a strategic priority, in order to develop the digital economy and offer improved educational and career opportunities to Ekiti children. Ekiti State only began offering ICT training in schools in 2015, and teachers' skills and resources were insufficient to deliver this new strategy.

Researchers from the Northumbria University Digital Learning Lab (DLL) have an established research history in applying digital literacy and access to technology to the field of education. Initial DLL research [**R1**-**R3**] established the use of digital games to teach mathematics to children, and these early results were followed up by studies of their acceptance and incorporation into the curriculum by teachers in Nigeria [**R4**-**R6**].

DLL established that few studies have either examined the design process for digital educational games or considered how they can provide engagement experiences comparable to those found

in entertainment-focused games [**R1**, **R2**]. Even fewer studies have specifically investigated how aspects of inclusivity and diversity can be built into games [**R1**, **R2**]. A series of qualitative interviews and surveys with students and young people (aged 7-16) investigated what features of entertainment games children engaged with. This led to a 'framework' of features that could be used to build a more sustained and effective learning experience in educational games [**R1**]. These included: clarity of goal, thematic appeal, visual appeal, rewards, feedback, social interaction, creativity, challenge, and immersion [**R1**, **R2**].

DLL applied this framework to a new mathematics teaching game, *SpeedyRocket,* which used spaceflight to teach basic mathematical principles. By embedding the identified engagement factors into the design and development of *SpeedyRocket*, researchers created an immersive educational experience that not only offered the key entertainment factors that typically engage children, but also empowered student learning [**R2**, **R3**]. *SpeedyRocket* adapted to the learning pace of the student and offered learners some level of control and ownership of the learning process, thereby fostering better understanding and retention of concepts [**R2**]. The researchers evaluated engagement factors with children in Ekiti State by asking participants to rank them according to how they affected their enjoyment of the game. This revealed gendered differences; male students preferred to play games that are challenging and centred on achievement, competition, and feedback; females were more interested in instructive games that provided clear aims and allowed them to interact socially and share their experience with others [**R2**].

In addition to this work, DLL also considered the needs of teachers in schools with differing access to technology, internet, and electricity [**R4**-**R6**]. DLL adapted a pre-existing Technology Acceptance Model (TAM) – an evaluation tool used to assess how the design of some technology or artefact meets the needs of the intended users, in order to encourage its adoption. This modified TAM included factors identified by teachers that made them more or less likely to use digital games in the classroom [**R4**, **R5**]. A mixed methods approach drew on DLL's previous studies with teachers, complemented by action research with 220 teachers in Nigeria, and generated insights into how the modified TAM could better incorporate contextual external variables specific to the teaching environment [**R4**, **R5**]. For example, although the internet and digital devices are becoming increasingly accessible to people in Nigeria, classroom adoption and integration levels are still low, due to low teacher confidence and lack of familiarity with using digital tools in classrooms [**R6**]. The modified TAM was then tested independently by discipline experts [**R4**] and 20 science teachers in Ekiti State, Nigeria, through a combination of focus groups and questionnaires [**R6**]. Results showed that the main barriers to the adoption and integration of ICT in the classroom included a lack of adequate and well-trained personnel, poor internet service, and high cost of access [**R6**].

Taken together, the insights of these research projects resulted in the DIGISTEM project (2018-2020), managed by DLL researchers. The project aim was to use digital tools to address (1) stereotypical and negative views held by young people about science and scientists, (2) the gendered delivery of science and digital education in formal learning environments, and (3) the narrow aspirations of young people. The game engagement framework [**R1**, **R2**] led to the development of *SpeedyRocket* [**R2**, **R3**], which, together with the TAM work [**R4**-**R6**], formed the basis of the case for support for DIGISTEM. DIGISTEM was delivered in partnership with the Nigerian StemRes Learning Initiative and sponsored by the World Bank through their State Education Program Investment Project.

3. References to the research (indicative maximum of six references)

R1. **Opeyemi Dele-Ajayi**, **Jonathon Sanderson**, **Rebecca Strachan**, and **Alison Pickard** (October **2016**) 'Learning mathematics through serious games: An engagement framework' *IEEE Frontiers in Education Conference* (pp. 1-5). IEEE https://doi.org/10.1109/FIE.2016.7757401

R2. **Opeyemi Dele-Ajayi**, **Rebecca Strachan**, **Alison Pickard**, and **Jonathon Sanderson** (October **2018**) 'Designing for All: Exploring Gender Diversity and Engagement with Digital

Educational Games by Young People' *IEEE Frontiers in Education Conference* (pp. 1-9). IEEE https://doi.org/10.1109/FIE.2018.8658553

R3. **Opeyemi Dele-Ajayi**, **Rebecca Strachan**, **Alison Pickard**, and **Jonathon Sanderson** (**2019**) 'Games for Teaching Mathematics in Nigeria: What Happens to Pupils' Engagement and Traditional Classroom Dynamics?' *IEEE Access* **7**:53248-53261 https://doi.org/10.1109/ACCESS.2019.2912359

R4. **Opeyemi Dele-Ajayi**, **Rebecca Strachan**, **Jonathon Sanderson**, and **Alison Pickard** (April **2017**) 'A modified TAM for predicting acceptance of digital educational games by teachers' *IEEE Global Engineering Education Conference* (pp. 961-968) https://doi.org/10.1109/EDUCON.2017.7942965

R5. **Opeyemi Dele-Ajayi**, Victor, A. M.*, Oluwafemi, A.*, **Emma Anderson**, **Rebecca Strachan**, and **Itoro Emembolu** (April **2019**) 'Barriers and identified solutions to the integration of digital technologies in the classroom: A case study of teachers in Nigeria' *IEEE Global Engineering Education Conference* (pp. 953-958) https://doi.org/10.1109/EDUCON.2019.8725160

R6. **Opeyemi Dele-Ajayi**, **Rebecca Strachan**, **Emma Anderson**, and Victor, A.M.* (October **2019**) 'Technology-Enhanced Teaching: A Technology Acceptance Model to Study Teachers' Intentions to Use Digital Games in the Classroom' IEEE Frontiers in Education Conference (pp. 1-8) https://doi.org/10.1109/FIE43999.2019.9028527

*External collaborators: Victor, A. M. and Oluwafemi, A. - employees of the StemRes Learning Initiative, Lagos, Nigeria

Research funding
G1. PI Opeyemi Dele-Ajayi, World Bank funded Nigeria - State Education Program Investment Program, 2018-2020, GBP83,777.10 (P122124)

4. Details of the impact (indicative maximum 750 words)

Northumbria University's DLL advised Ekiti State on key policies, programmes, and interventions around digital literacy and technology-enhanced teaching, and accepted an invitation from the Deputy Governor to design interventions with the Ministry of Education, Science, and Technology (MoEST). Professional development courses, workshops, seminars, and training sessions were delivered to their schoolteachers in 2018-2020 through the DIGISTEM project and Northumbria University's in-house STEM outreach team NUSTEM, in partnership with Nigerian educational outreach organisation 'StemRes'. These activities, in addition to DLL leading the design and delivery of the online teaching response to the Covid-19 crisis with MoEST, enabled rapid innovation in digital learning in Ekiti State.

4.1 Enhanced digital skills and confidence for teachers to use technology in the classroom

DIGISTEM directly trained 25 outreach staff employed by the Ekiti State [**E1**] using DLL research on student engagement, the modified TAM to encourage adoption of technology and the *SpeedyRocket* game. These trainers then worked with teachers to develop their digital skills and increase their confidence in using technology in the classroom. This training empowered the use of digital technology by teachers in the classroom, integrated technology into teaching practice across the state for the first time, and enhanced the overall effectiveness of teaching. As Mr Eweje Olaonipekun, the STEM and Digital Education Officer for Ekiti State, explains:

> *'[t]he project was a huge success, and it has changed education in our state…The training programmes designed and delivered as part of the DIGISTEM project moved our teachers from novice to people who are confident to use the devices in improving not just teaching and learning but administrative tasks'* [**E1**].

Mr Olaonipekun confirmed that the DIGISTEM training has so far reached a total of 3,745 teachers and more than 10,000 pupils in the state [**E1**; **E2**, p16]. Mr Alufa Adedamola, Programs Manager for the DIGISTEM project, described how practice in the classroom has changed: *'[w]hat DIGISTEM brought was a totally different approach from what has been in operation in our educational ecosystem'* [**E3**]. One teacher characterised the problem teachers faced as a feeling that '*we knew something was missing in our approach to teaching science, we felt there should be more creative ways to teaching these students*' [**E3**]. Prior to working with DLL and the DIGISTEM project, teachers '*were ready to pass across quality knowledge to the students, but the methods in use were not very effective'* [**E3**]. However, by April 2019 *'65% of the teachers we engage with report a better self-efficacy to deliver science in the classroom*' [**E4**].

4.2 Increased enrolment, engagement, and inclusivity in STEM education in public schools

DIGISTEM worked directly with 2,355 young people aged 7-16 in 50 partner schools in Nigeria to specifically enhance their engagement with science and mathematics subjects through digital gaming [**E5**, p3]. Evaluation performed by the team showed that the revised teaching practice '*resulted in a 30% increase in the number of young people choosing to do science across our partner schools*' [**E4**].

Partner teachers who had participated in the DLL-led training reported to Mr Adedamola that '*enrolment in the science class has now increased and that could not be unconnected to the fact that students offering science now find it interesting to learn, you know it's contagious when students discuss how they were taught chemistry*' [**E3**].

The project also had wider positive impacts on the public school system. Mr Oloanipekun explained that:

> *[t]hree years ago, you wouldn't believe if someone said ICT education in a public school. Maybe one or two very expensive private schools ... no public school was doing any ICT class. It limited the possibilities for the students in these schools, but the confidence in public school education has increased shown by the increase in the enrolment across the schools where we have introduced ICT education'* [**E1**].

Improvements were also made in terms of addressing gender imbalance in STEM subjects, through training that was based on DLL research findings [**R2**, **R5**]. Mrs Afolalu Oluyemi, Headteacher of the Amazing Group of Schools, explained that the '*sessions around gender stereotypes and the importance of models have supported our teachers in selecting gender-balanced materials for use in the classroom…[t]his in turn has resulted in girls knowing that they can study science and that science is for them*' [**E6**].

4.3 Implemented COVID-19 lockdown digital skills teacher-training to sustain children's education

During the COVID-19 lockdown, training plans were rapidly developed to help teachers to deliver teaching remotely. Mr Adegbola Adesina, Change Management Officer of the Ekiti State Ministry of Education, Science and Technology, worked with Dr Opeyemi Dele-Ajayi of the DLL to address the challenges they faced, explaining that at the beginning of lockdown they started using state TV and radio for teaching, but this raised problems around learning assessment and feedback, and caused concerns about the quality of delivery [**E7**]. Dr Opeyemi '*designed a training plan leveraging on everyday tools like Google forms, WhatsApp and Telegram, Endnote, etc. to help our teachers reinvent the delivery of teaching and learning activities during the pandemic*' [**E7**]. As a result of this work '*we have now been able to reach a lot more students during the pandemic, and the teaching is no longer one-way through the radio and TV, we are now doing assessments, getting feedback on learning from both parents and students using an array of tools and technologies'* [**E7**]. This training has been rolled out to over 5,000 teachers in the state [**E7**].

This intervention was only possible due to DLL's existing involvement in DIGISTEM, and it was based on principles developed and experience gained during the project. The intervention significantly aided student engagement and retention, and improved the ability of Ekiti State to maintain teaching:

> '*We have been able to sustain these efforts and continue to deliver teaching, ensuring we do not lose our students... Our state is one of the few states in Nigeria to maintain daily learning [during] this period due to the support we received. We would not have been able to achieve the level and quality of reach we have done and continue to do if not for the new ways of working we embraced as a result of Dr. Opeyemi's work*' [**E7**].

5. Sources to corroborate the impact (indicative maximum of 10 references)

Ref.	Source of corroboration	Link to claimed impact
E1	Interview with Eweje Olaonipekun, STEM and Digital Education Officer for Ekiti State, Ministry of Education, Science, and Technology	Impact on teacher training and classroom practices
E2	EdTech in Nigeria report 2020	Scope and scale of DIGISTEM project
E3	Testimonial - Mr Alufa Adedamola, Programs Manager for the DIGISTEM project	Teacher comments on change in classroom practice and student engagement/enrolment
E4	Testimonial - Victor Ayodele, Director of StemRes Learning Initiative	Evaluation of project on student enrolment and teacher training
E5	DIGISTEM website screenshots	Direct engagement of DIGISTEM with teachers and students
E6	Testimonial - Mrs Afolalu Oluyemi, Headteacher, Amazing Group of Schools	Impact on gender inclusive education in Ekiti State
E7	Interview with Adegbola Adesina, Change Management Officer for Ekiti State, Ministry of Education, Science, and Technology	Impact on digital education tools on maintaining schooling and changes to teaching practice, learning, and assessment during the COVID-19 crisis