Case Study of the Use of Biometrics in Impact Network Schools in Rural Zambia

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Executive Summary

In this report, we present a case study of the use of biometrics to track student and teacher attendance in primary schools in rural Zambia. Impact Network and Simprints are implementing a pilot with the fingerprinting technology in eight primary schools that use the eSchool 360 model to improve learning outcomes for students in rural eastern Zambia.[1,2,3] Impact Network's pilot project aims to use fingerprinting technology to enable more frequent analysis of attendance trends and trigger follow-ups with absent students, with the ultimate goal of improving student attendance rates. This study examines the experiences of teachers, school staff, and students with the use of biometrics to track attendance, as well as the operational performance of the technology. The study was based on qualitative and quantitative methods, including key informant interviews with staff and teachers at Impact Network schools, focus group discussions with students, and quantitative analysis of student attendance data.

Background

Accurate attendance data are critical, since teacher and student attendance influence students' learning outcomes (Guerrero et al., 2013). Previous studies also suggest that monitoring attendance can be effective in improving teacher and student attendance (Guerrero et al., 2013; Snilstveit et al., 2016).[4] Yet, tracking attendance is challenging in low- and middle-income countries because schools generally rely on paper-based systems that may be inaccurate, susceptible to manipulation, and of limited use in informing decisions in a timely manner (Kremer & Chen, 2001). Zambia only has limited access to reliable school attendance data with the most recent national attendance statistics dating back to 2013 (Examinations Council of Zambia, 2013). Biometric tools to track teacher and student attendance present an opportunity to improve the accuracy of attendance data (Gelb & Clarke, 2013).

This study contributes to the literature by presenting one of the first studies on the application of biometric technology for education attendance in rural Africa. Although international development actors increasingly use biometric tools to improve efficiency in programming in

[1] Impact Network's eSchool 360 model incorporates three potentially high-impact interventions that could provide important complementarities including e-learning technology, ongoing teacher training and professional development, and community ownership. AIR is conducting a separate study on the impact and fidelity of implementation of the eSchool 360 model (De Hoop et al., 2020).

[2] A cluster randomized controlled trial on the impact of Impact Network's eSchool 360 model shows that the program has positive intention-to-treat effects of 0.40 standard deviations or 3.5 percentage points on early grade reading assessment scores and 0.22 standard deviations or 4.9 percentage points on early-grade math assessment scores 14 months after the start of the program implementation and in the absence of the biometrics system (De Hoop et al., 2020).

[3] Impact Network halted the use of biometrics to track attendance in March 2020 due to potential risks posed by the COVID-19 pandemic.

[4] The evidence is more mixed on the effects of monitoring attendance on learning outcomes (Guerrero et al., 2013; Snilstveit et al., 2016).

sectors such as health, little evidence exists on the use of biometric technology in education settings.

Methodology

The American Institutes for Research (AIR) used qualitative and quantitative methods to investigate how biometrics were used to track student and teacher attendance as well as perceptions of the fingerprinting technology within Impact Network schools in Zambia. For the qualitative research, we conducted two rounds of data collection and purposively sampled five of the eight schools that used biometrics to track attendance, including the two schools where the biometrics system was first piloted in 2017. During the first round of data collection, we conducted in-person interviews with teachers and Impact Network staff, focus group discussions (FGDs) with students, and observed the implementation of the biometrics system in the classroom in the first two schools using the fingerprinting technology in March 2019. As part of the first round of data collection, we also conducted virtual interviews with Impact Network staff based in New York and Simprints staff based in London. From a preliminary analysis of the data, we realized that we did not have enough information on how teachers and administrative staff use the attendance information obtained through biometrics and decided to conduct a second round of data collection with teachers and Impact Network staff in Zambia. We opted to carry out the second round of data collection remotely to avoid delays caused by travel restrictions related to the COVID-19 pandemic. We conducted phone interviews with teachers and Impact Network staff from three additional schools during the second round of data collection in July 2020. On the completion of the second round of data collection, we had interviewed teachers in five of the eight schools that used the biometrics system to track attendance.

For the quantitative research, we analyzed student attendance data for all eight schools using biometrics during the three academic terms of 2019 to compare daily student attendance data based on the fingerprinting system with student attendance based on teacher self-reports. This analysis served to examine the accuracy of the biometrics system.

Findings

Respondents perceived the fingerprinting system as an accurate, efficient, and secure method of tracking individual-level attendance and felt that it encouraged students to attend school. However, the use of fingerprinting technology was hampered by operational challenges related to interference with instructional time, and technical and data-related problems. Most teachers believed that the training they received effectively prepared them to use the fingerprinting technology. Impact Network staff, teachers, and students noted that using biometrics increased the accuracy of attendance data compared with relying on paper-based records. Teachers and Impact Network support staff also felt that the use of biometrics to track attendance

encouraged regular attendance, since students were excited to use the scanner. Administrative staff reported that biometric attendance data helped inform resource allocations and target student follow-ups. Yet, few teachers described using attendance data to conduct follow-ups with absent students, and administrative staff recommended providing more frequent feedback to teachers and designating another staff member to support follow-up services.

A triangulation of quantitative and qualitative data revealed discrepancies between the biometric and teacher-reported attendance data, which likely reflects greater accuracy of biometric attendance data compared with teacher-reported student attendance data. The quantitative analysis indicated that biometric-reported attendance rates were much lower than teacher-reported attendance, with a 14 percentage-point difference in Term 1, 15 percentage-point difference in Term 2, and 20 percentage-point difference in Term 3. The difference between biometric-reported and teacher-reported attendance data is likely caused by greater accuracy of the biometric data. Teachers and students noted that teacher-reported student-attendance data are more prone to error, however, the accuracy of biometric attendance data needs further scrutiny despite reports indicating that the biometric system had less than a 1% error rate in matching student fingerprints with a unique ID. However, it is also possible that part of the lower attendance records are indicative of input errors in those cases where the fingerprinting system failed to read students' thumbprints.

Our qualitative data suggest that fingerprint scanning using the Vero scanners often took longer than the expected 10 to 15 minutes in the observed classrooms because of operational challenges, for example fingerprints were not always instantly recognized by the application or when devices lost charge. Some teachers worried that using fingerprint scanning took away from instructional time caused by these operational challenges. Across schools, several teachers noted that they were required to record attendance in a manual register, in addition to collecting biometric data, thereby eliminating any potential time savings that the fingerprinting technology might have produced.

Respondents also noted challenges associated with using the biometric devices which complicated the ability to sync and act on data. Several teachers noted that Vero scanners (the devices used to scan students' fingerprints) were not consistently charged when needed, and some reported that biometric data were not easily synced in areas with a spotty network. Further, the biometrics attendance system lacked a mechanism for disaggregating trend data according to gender, age, or reason for absence, which could deepen teachers' and school administrators' understanding of attendance trends.

Recommendations

Based on these findings, we present the following recommendations:

- **Impact Network should develop strategies to ensure that fingerprint scanning does not take away from instructional time.** We recommend that Impact Network explore strategies to decrease the incidence of unrecognized fingerprints (such as registering new fingerprints in the system more frequently) and develop a protocol to speed up the switch from scanning to searching the Impact Network ID, in case the application fails to recognize a student's fingerprint. Also, Impact Network should work closely with teachers to ensure that students are engaged in other activities like reviewing their notes when fingerprint scanning is taking place.
- **Impact Network should consider providing incentives for teachers to conduct follow-up visits with absentee students based on attendance data and develop a monitoring mechanism to track whether follow-up visits are occurring with absentee students.** While most teachers reported receiving attendance data, the evidence that these data are used to conduct follow-ups is mixed. Providing incentives for teachers and monitoring the occurrence of follow-ups could help maximize the use of attendance data and increase teacher accountability to school administrators for conducting follow- ups with absentee students. Determining the type of incentives that are effective will likely require some more investigation.
- **Impact Network should create a functionality to incorporate gender information and "reason for absence" into attendance data.** Impact Network staff and teachers agreed that gender disaggregation would improve understanding of differential attendance trends between boys and girls. Further, we found general agreement that including granularity in the "absent" category—for example, illness, tardiness, or transfer—would enable schools to better identify and address attendance trends. For example, Impact Network could consider adding a module to the attendance tracking system that lists students whose fingerprints were not scanned on a given day and allows teachers to list the reason for absence (if known). Impact Network could then incorporate this information in the attendance data that teachers receive and in this way the information could help inform follow up visits.

Introduction

In this report we present a case study of the use of a fingerprinting technology used to track attendance in schools in rural Zambia. Biometric tools present an opportunity to improve the accuracy of attendance data in low- and middle-income countries such as Zambia, which use paper-based attendance systems that may be inaccurate and not timely enough to be useful (Gelb & Clarke, 2013; Kremer & Chen, 2001). Impact Network and Simprints are implementing a pilot with the fingerprinting technology in eight primary schools that use the eSchool 360 model, to improve learning outcomes for students in rural eastern Zambia.[5,6] This study examines the experiences of teachers, school staff, and students with the fingerprinting technology, as well as its operational performance. The study was based on qualitative and quantitative methods, including key informant interviews (KIIs) with staff and teachers at Impact Network schools, focus group discussions (FGDs) with students, and analyses of attendance data. AIR's case study of biometrics used in Impact Network schools is the first study on the use of fingerprinting technology in education settings in rural Africa.

The rest of this report is organized as follows: First, we review background research on the quality of attendance data in schools and biometrics. Next, we provide an overview of Impact Network's partnership with Simprints. We then discuss the methodology for the study, followed by findings and recommendations for the implementation of biometrics in Impact Network schools.

Background

Attendance Tracking for Education

Accurate attendance tracking is critical because teacher and student attendance can influence student's learning outcomes (Guerrero et al., 2013). Yet, tracking attendance is challenging in low- and middle-income countries because schools rely on paper-based systems that may be inaccurate, susceptible to manipulation, and of limited use in informing decisions in a timely manner (Kremer & Chen, 2001). For example, teachers and principals may inflate attendance

[5] Impact Network's eSchool 360 model incorporates three potentially high-impact interventions that could provide important complementarities including e-learning technology, ongoing teacher training and professional development, and community ownership. AIR is conducting a separate study on the impact and fidelity of implementation of the eSchool 360 model (De Hoop et al., 2020).

[6] A cluster randomized controlled trial on the impact of Impact Network's eSchool 360 model shows that the program has positive intention-to-treat effects of 0.40 standard deviations or 3.5 percentage points on early grade reading assessment scores and 0.22 standard deviations or 4.9 percentage points on early grade math assessment scores 14 months after the start of the program implementation and in the absence of the biometrics system (De Hoop et al., 2020).

data when the allocation of education resources is contingent on levels of teacher and student attendance (Kremer & Chen, 2001). Biometric tools to track teacher and student attendance present an opportunity to improve the accuracy of attendance data (Gelb & Clarke, 2013).

Teacher Absenteeism and Learning Outcomes

Teacher absenteeism can reduce the opportunities for students to learn at school, for example, by reducing instruction time (World Bank, 2018). A recent study conducted in Uganda, Mozambique, Tanzania, Kenya, Togo, Senegal, and Nigeria, showed that approximately 20% of the teachers were absent from school on a typical day (Bold et al., 2017). Further, teachers in poorer and more rural areas tended to be absent more often than those in more affluent and urban areas (Alcázar et al., 2006). Zambia experiences similar challenges, as shown by data from the 2013 Demographic and Health Survey, demonstrating that 18% of Zambian teachers in surveyed schools were not attending their classrooms at the time of the data collection. These high absence rates could have large implications for learning outcomes because previous evidence showed that teacher absence led to a decline of 20%–30% in learning gains in mathematics and English in Zambia over the course of 1 year (Das et al., 2007). A Public Expenditure Tracking Survey (PETS) and Quantitative Service Delivery Survey (QSDS) study in Zambia also estimated that factors such as teacher absence, pupil absence, and school closures represent about a third of the learning time budgeted for in a school year for Grade 9 (World Bank, 2015).

Student Absenteeism

Despite global progress on education, student retention rates remain low in developing countries (World Bank, 2018). In Zambia, a study conducted by the Zambia Council of Examination found that the prevalence of school absenteeism was widespread in the country, and highest in Grade 9. Over a period of 13 years, the average absenteeism during Grade 7 examinations was 9.0%, and the average absenteeism during Grade 9 examinations was 11.03% (Examinations Council of Zambia, 2013). High rates of student absenteeism can have lasting undermining effects on the attainment of quality education. Evidence from a systematic review shows that improvements in enrollment and retention rates translate into better learning gains for students (Krishnaratne et al., 2013).

Effectiveness of Interventions

Teacher Absenteeism

Evidence from experimental and quasi-experimental studies shows that several interventions have effectively reduced teacher absenteeism in low- and middle-income countries. A randomized controlled trial showed that a program in India reduced teacher attendance by 20 percentage points after making a teacher's salary a direct function of their attendance as

measured by cameras (Duflo & Hanna, 2005). A quasi-experimental study in Peru showed that a similar program achieved improvements by providing monetary incentives to teachers based on the measurement of teacher attendance by trained parents (Cueto et al., 2008). Another quasi-experimental study in El Salvador showed that decentralization of educational responsibility to communities also enabled a reduction in teacher absence (Jimenez & Sawada, 1998). Finally, a randomized controlled trial of a merit scholarship program in Kenya showed statistically significant effects on teacher attendance (Kremer et al., 2009). However, a systematic review of interventions to reduce teacher absence showed that the programs only led to improvements in learning outcomes in some cases, suggesting that while teacher attendance is important, it may not always be sufficient to improve student achievement (Guerrero et al., 2013).

Student Absenteeism

Several studies suggest that cash transfers may be the most effective approach to improve student enrolment and attendance, but they do not typically improve learning outcomes. A systematic review by Snilstveit et al. (2016) showed that conditional cash transfers had the largest and most consistent positive effects on student attendance and enrollment but only showed limited evidence for positive effects on learning outcomes. In Zambia, there is limited evidence of the effects of interventions targeting student absenteeism, something that may be related to the limited attendance-monitoring data in the country. For instance, an evaluation of the Global Partnership for Education's 2011 through 2019 support for Zambia's education system revealed that Education Management Information Systems' efforts to track student attendance through census tool revisions had not been achieved by the National Implementation Frameworks III—the implementation plan for attaining indicators outlined in the National Development Plans (Universalia, 2019).

Biometrics: A Possible Solution?

AIR's evaluation of the use of biometrics to track attendance in Impact Network schools is one of the first studies investigating the use of fingerprinting technology to track student attendance in rural Africa. This evaluation thereby contributes to the growing evidence base on the feasibility and fidelity of using biometrics in different sectors, ranging from health to education, and helps build up the limited evidence base on attendance monitoring in Zambia. International development actors are increasingly using biometric applications to enable formal identification and authentication of program participants. The World Bank estimates that 1.1 billion people worldwide lack formal identification (World Bank, 2017), which excludes them from crucial public services and the exercise of their legal rights. Biometric applications can improve the accuracy of the measurement of attendance, although they can also lead to privacy risks associated with data protection (Gelb & Clarke, 2013). A literature review by Gelb and Clarke notes 160 cases in which biometric identification is used for economic, political, and

social purposes in developing countries. The review found limited evidence related to interventions using biometric technology in education settings, demonstrating an important evidence gap. One of the few studies in this area focuses on the Liberia Teacher Training Program, which uses a biometric ID system to support personnel management. The program identified 10,000 ghost workers, who were then fired by the Ministry of Education, thus generating significant cost savings (United States Agency of International Development [USAID], 2017). Other education interventions incorporating biometric applications include a project using fingerprints to authenticate the identity of standardized test takers in Nigeria and an intervention using biometrics to reduce teacher absenteeism in India (Gelb & Clarke, 2013).

Impact Network's Partnership with Simprints

From 2017 to 2020, Impact Network used the biometric technology in eight of its schools in Zambia to increase the accuracy of attendance tracking of teachers and students, and facilitate analysis of attendance trends. Impact Network faces several challenges associated with manually tracking attendance that the fingerprinting technology could resolve. For example, many students have the same name, and with unknown dates of birth and missing addresses duplicate names are difficult to verify. In addition, paper attendance registers tend to get dirty and are often hard to read. These issues make it difficult to match students with their information. Consequently, Impact Network staff is often unable to obtain accurate student attendance data using manual tracking, and this limits their ability to address issues like student absenteeism.

Simprints is a nonprofit technology startup that develops affordable biometric devices for use in rural areas, where problems such as cracked or dry fingerprints are common. Starting in 2017, Impact Network and Simprints rolled out a fingerprinting system to track attendance for teachers and students in a sample of eight Impact Network pilot schools.[7] The system consists of a fingerprint scanner, known as Vero, connected with a mobile phone with the CommCare platform.[8] Teachers and students scan their fingerprint on the Vero each day, and the CommCare application on the mobile phone records attendance. Once a week, designated "data syncers" at each school hot-spot the mobile phones to sync the data with CommCare. The data then become available to Simprints and Impact Network staff, who analyze attendance and performance data and produce monthly reports for teachers and management staff. These reports include data on student attendance and flag students who are absent for teachers to follow up with. Currently, Impact Network prints attendance reports based on biometric data

[7] These eight schools were not part of the cluster randomized controlled trial discussed in De Hoop et al. (2020).
[8] Both devices are powered by solar, like the eSchool 360 tablets.

and physically distributes these reports to schools, although Impact Network hopes to distribute reports via text in the future.

Impact Network halted the implementation of biometrics for attendance tracking in March 2020 due to potential risks associated with the COVID-19 pandemic. The organization plans to soon reevaluate the use of the biometrics system.

Case Study Methodology

Research Questions

This study focuses on the implementation of biometrics to track attendance, and seeks to answer the following research questions:

1. How are biometrics used to track attendance in Impact Network schools?
2. What are administrators', teachers', and students' experiences using biometrics to track attendance? How is the use of biometrics perceived by administrators, teachers, and students?
3. How accurate are attendance data captured by the Vero scanners? How are administrators, teachers, and school staff using biometric attendance data to inform decision making related to school management?
4. What are the perceived benefits of using biometrics to record attendance?
5. What are the perceived challenges associated with using biometrics to track attendance?
6. What can be improved about the implementation of biometrics to track attendance?
7. To what extent are participants satisfied with the training on the use of biometrics to track attendance?

Qualitative Design

AIR conducted interviews with Impact Network and Simprints staff and qualitative data collection at five Impact Network schools in Zambia to understand how biometric devices (Vero scanners) are used to track attendance, as well as teacher and student experiences using the devices for this purpose. We conducted two rounds of school-level data collection. During the first round, we adhered to a case study approach and conducted a small number of in-person interviews with teachers and Impact Network staff. During the analysis phase, we realized that we had not managed to reach saturation with our sample from the first round of data collection. We therefore decided to implement a second round of key informant interviews

(KIIs) to expand our sample. During the second round, members of the research team conducted interviews with teachers and Impact Network staff from three additional schools until we concluded that we were hearing the same responses across respondents and schools, thereby reaching saturation (Bernard, 2011; Seale, 1999).

We carried out the first round of data collection in March 2019 and conducted in-person KIIs with teachers and support staff, FGDs with students, and classroom observations of fingerprint scanning in the first two schools to implement the biometrics system. We carried out the second round of data collection remotely in July 2020 to avoid delays in data collection associated with COVID-19-related travel restrictions. During this round, we conducted remote KIIs with teachers, Impact Network support staff at three additional schools, and Impact Network administrative staff.

Key Informant Interviews

We conducted one KII with the Simprints project manager, three with Impact Network administrative staff, four with Impact Network staff supporting the biometrics system (includes Simprints champions and school support officers),[9] and eight with teachers. These KIIs focused on training, implementation, challenges and successes, data use, and perceptions of the biometrics system.

Focus Group Discussions

We conducted two FGDs with students in Grades 3 and 4 to understand their experiences of fingerprint scanning and the way it affected the classroom environment. FGDs also aimed to identify factors that facilitated or inhibited classroom implementation of the biometrics system.

Classroom Observations

We conducted three classroom observations at each of two pilot schools included in the sample (total of six observations). Classroom observations enabled us to examine the way the biometrics system is used by teachers in the classroom and the extent to which there are any operational challenges.

Sampling

Data collection took place in five of the eight schools where the biometrics system is currently implemented. Table 1 includes descriptive information on the schools we sampled. Our sample included the two schools where the biometrics system was first piloted in 2017 (Joel and Mnyaula) as well as three additional schools that started using the biometrics system in 2018 (Kanyelele, Mkale, and Mkhazika). We purposively sampled schools of different sizes, distances

[9] Simprints champions are Impact Network staff members who have received special training on the biometrics system and are responsible for monitoring and troubleshooting the biometrics system in Impact Network schools.

from the city center, and overall performance to capture implementation across a variety of school settings (see Table 1). Table 2 provides a summary of the data collection approaches and respondents.

Table 1. Descriptive Information on Schools Sampled

School	Size	Distance from district center	School performance
Joel	500 students (large)	~25 km	Overall attendance rates slightly below average, end-of-term exams average
Mnyaula	294 students (small/average)	~40 km	Overall attendance rates slightly above average, end-of-term exams average
Kanyelele	450 students (large)	~28 km	Overall attendance rates above average, end-of-term exams above average
Mkale	250 students (small/average)	~47 km	Overall attendance rates below average, end-of-term exams average
Mkhazika	220 students (small/average)	~16 km	Overall attendance rates slightly below average, end-of-term exams below average

Table 2. Qualitative Sampling for Case Study

Methods	Respondents	Number
First Round		
FGD	Students (Grades 3 and 4)	2 (total 16 students)
KII	Teachers	2
KII	Impact Network support staff	2
KII	Simprints staff	1
KII	Impact Network administrative staff	1
Classroom observation	Grades 1, 3, 4, 5, and 7(2)	6
Second Round		
KII	Teachers	6
KII	Impact Network support staff	2
KII	Impact Network administrative staff	2

Quantitative Design

In addition to collecting qualitative data, we analyzed student attendance data for all schools implementing the biometrics system during the three academic terms of 2019. We accessed data from the following sources:

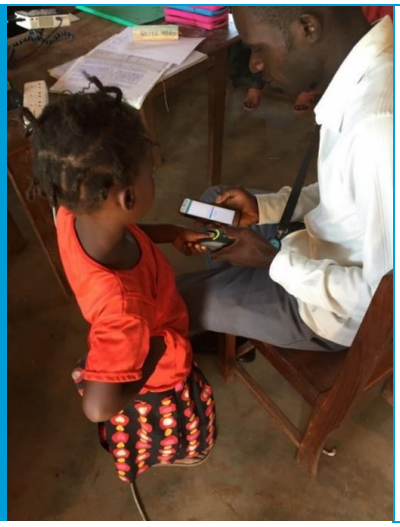
1. Biometric student daily attendance data: These data include term-wise daily attendance information for students enrolled in schools implementing the biometrics system in Grades 1 through 7.
8. Teacher-reported student attendance data: These data include term-wise attendance rates for students enrolled in schools implementing the biometrics system based on attendance data collected through end-of-term mobile data collection apps completed by teachers. Teachers go through all students in the attendance register, fill in the number of days that students attend, and then enter their exam results. These data are available for all students enrolled in these schools in Grades 1 through 7.10

We compared biometric student attendance data against teacher-reported attendance data for students enrolled in schools implementing the biometric system.

Findings

Figure 1. Fingerprint Scanning in an Impact Network Classroom

FINGERPRINT SCANNING OPERATIONAL PROCESS



- Fingerprint scanning usually occurs after students return from break or right after the end of classes.
- Teachers scan their own fingerprint before scanning the students.
- In some classes, students line up for fingerprint scanning, while in others, teachers bring the scanner to each desk.
- Students report being asked to use their left thumbs and remove dirt or ink from their thumbs to enable scanner to recognize fingerprints.
- Aside from operating the Vero scanner and mobile phone, teachers are also responsible for charging and pairing the devices.

[10] Although we also received teacher reported data on non-biometrics schools, we restrict the analysis in this report to schools implementing the biometrics system to enable a comparison of two different sources of attendance for the same group of students.

Administrative Staff Experience

Administrative staff reported that the biometric system provided accurate individual-level attendance data that helped inform resource allocations and target student follow-ups, although staff had hoped to share attendance data with teachers weekly instead of monthly to maximize opportunities for intervention in cases of recurring student absences. Staff reported that using biometrics provided the most accurate way to capture attendance data. Prior to the biometric system, Impact Network staff agreed that the manual register was prone to error because of name duplication across students. One respondent explained that, in contrast to numerous errors in the manual register, the biometric system had less than a 1% error rate in matching student fingerprints with a unique ID.

Staff also noted that the biometric system provided individual-level attendance data for each student to allow teacher follow-ups with students who were absent. Before the introduction of the biometric system, these individual-level attendance data did not exist until teachers compiled them at the end of each semester. If a particular student was absent from school for an extended period of time, administrative staff would not become aware of the absence until it was potentially too late to intervene. With the biometric system, administrative staff received individual-level data, which were reviewed by the academics team on a weekly basis. During these meetings, staff identified students who had been absent for several days and flagged them. The goal, then, was to share this information directly with teachers to encourage prompt follow-up. However, in practice, individual-level attendance data were only shared with teachers on a monthly or mid-term basis, which delayed intervention. Administrative staff noted that they were working to shorten the feedback loop in hopes of encouraging immediate follow-up to promote regular attendance and prevent student dropout.

Impact Network staff reported using biometric attendance data to inform decision making related to staffing and the distribution of materials to schools. For example, one respondent reported moving teachers around according to attendance trends. “If [we’re] seeing attendance issues at one school, we might shuffle teachers around to see if that helps. For example, we might place a more experienced teacher at that school.” The same respondent noted attendance data are also used to inform resource allocations across schools such as how many textbooks, exam books, and other school supplies, like pencils, are needed.

Teacher Experience

While teachers appreciated the accuracy of the biometric system, they also felt burdened by some of its operational challenges. Teachers said they were well supported by Impact Network support staff and appreciated the accuracy of the technology. One teacher said the accuracy of students’ attendance records would not be questioned when taken with the biometric system, which made her feel more confident about failing absentee students. Another teacher also

alluded to accuracy, adding that biometric attendance records were maintained for a longer period of time than the manual register.

Accurate attendance data provided by the biometric system helped Impact Network staff determine resource allocations such as staffing and material distribution across schools.

While data also helped identify students in need of follow-up services, Impact Network staff voiced the need to share this information with teachers in a more timely manner.

However, some teachers reported that fingerprint scanning took longer than expected, potentially disrupting instructional time. Further, although they used the biometrics system to track attendance, teachers were still responsible for recording children's attendance in the manual registers. Several teachers discussed the requirement to record attendance both manually and through biometrics as time-consuming, and some described it as a burden. For instance, one teacher stated, "We see [the biometric system] as not helping because we are doing two things at the same time—registration on the phone and registration in the register. So, we see it like we are being punished, ok, to do two things." This suggests that the time it takes to operate the biometric system, as well as the school requirement to track attendance in two different ways, may be onerous to teachers.

Student Experience

Students mostly had positive perceptions of fingerprint scanning but noted that fingerprints were sometimes not recognized by the application, and this resulted in class delays. Most students in FGDs reported positive perceptions of the biometrics system. Perceptions ranged from an overall excitement about using the technology to views that the biometrics system was an accurate way of tracking attendance. For instance, a student said, "When it's time to do the fingerprint, students are happy." Another student explained that he liked the biometrics system because he believed it was accurate. "We do like it . . . because [if] you have not heard your name when they were calling [for the manual register] you can just be quiet because . . . for the Vero [fingerprint scanner] they would have seen that you are there." This view, shared by other students, suggests that the biometrics system was perceived as a more accurate method of attendance taking than the manual register.

However, a few students reported that the scanner would not recognize their fingerprint even if their hands were not dirty, which delayed classes. One student said, "[The scanner] should not be rejecting some names. Even when there is not dirt on the hand, it doesn't show the name." In this situation, students were asked to give their Impact Network ID number to the teacher. Students said that when too many fingerprints were unrecognized by the application, classes were delayed.

Successes

The section below presents the main successes from the implementation of the biometrics system to track attendance, including respondents' positive perceptions of trainings and their view of the software as an accurate, efficient, and secure method of tracking attendance that enables teachers to flag students in need of follow-up services.

Trainings Effectively Prepared Teachers to Use the Fingerprinting Technology

Teachers and Impact Network support staff reported positive perceptions of the trainings, with only two out of eight teachers stating that they did not feel the training was sufficient to prepare them to use the biometrics system in their classrooms. Teachers reported that trainings successfully showed them how to pair and unpair the Vero devices with the phones, to search for children using their ID numbers, and to deal with common fingerprinting issues such as dirty or dry thumbs by having children rub their thumbs on their necks. As one teacher from Kanyelele School put it, "After going back to my workplace I was able to practice what I was trained on." Of the two teachers who were not satisfied with the training, one teacher highlighted the importance of providing more training sessions to teach the biometric system operations and use, and both teachers noted that the training underestimated the time it takes to complete fingerprint scanning with the Vero scanner (see "Operational Challenges" section for more information on the expected time for fingerprint scanning). Most of the respondents who attended two trainings reported improvements in the second training. Impact Network staff noted that the second training was more streamlined, giving the example that they did not try to cover all possible error messages during the training and instead focused on what steps teachers should take in the event that any error message occurs.

The Biometrics System Is Widely Perceived as an Accurate, Efficient, and Secure Method of Tracking Attendance

Administrative staff, teachers, and students widely perceived biometrics as an accurate and trustworthy way to monitor attendance. Several teachers and Impact Network staff who supported the biometrics system believed that biometric attendance records were more accurate than the manual registers because they were less prone to human error. As a result, administrative staff reported relying on biometric data to determine resource allocations such as staffing and material distribution across schools. A teacher from Mkhazika school stated, "In the manual register, we might make some mistakes marking the pupil's attendance. With [the biometric system], those mistakes will not be done. . . . Using the phone . . . is a good way to capture information rather than using the register." A teacher from Joel school agreed, adding that the format of the manual registry was prone to error. "By using the [biometric system], that

information won't be cooked or won't be mistaken in any way, while the register . . . has got some boxes that you can even not see properly and then you indicate someone who was present as absent." Further, the operations coordinator, who supported teachers from Impact Network schools with operation of the biometrics system, believed that scanning fingerprints was more accurate than calling out names for the manual registry because students were not able to answer for one another.

> [The biometrics system is a] very useful tool because it gives the teachers chance to interact with the students. [It] gives teacher[s] [a] physical countdown. [With manual register] friends answer back for students, and teachers will count students as being there when they are not. [The biometrics system's] major benefit is that it's more accurate.

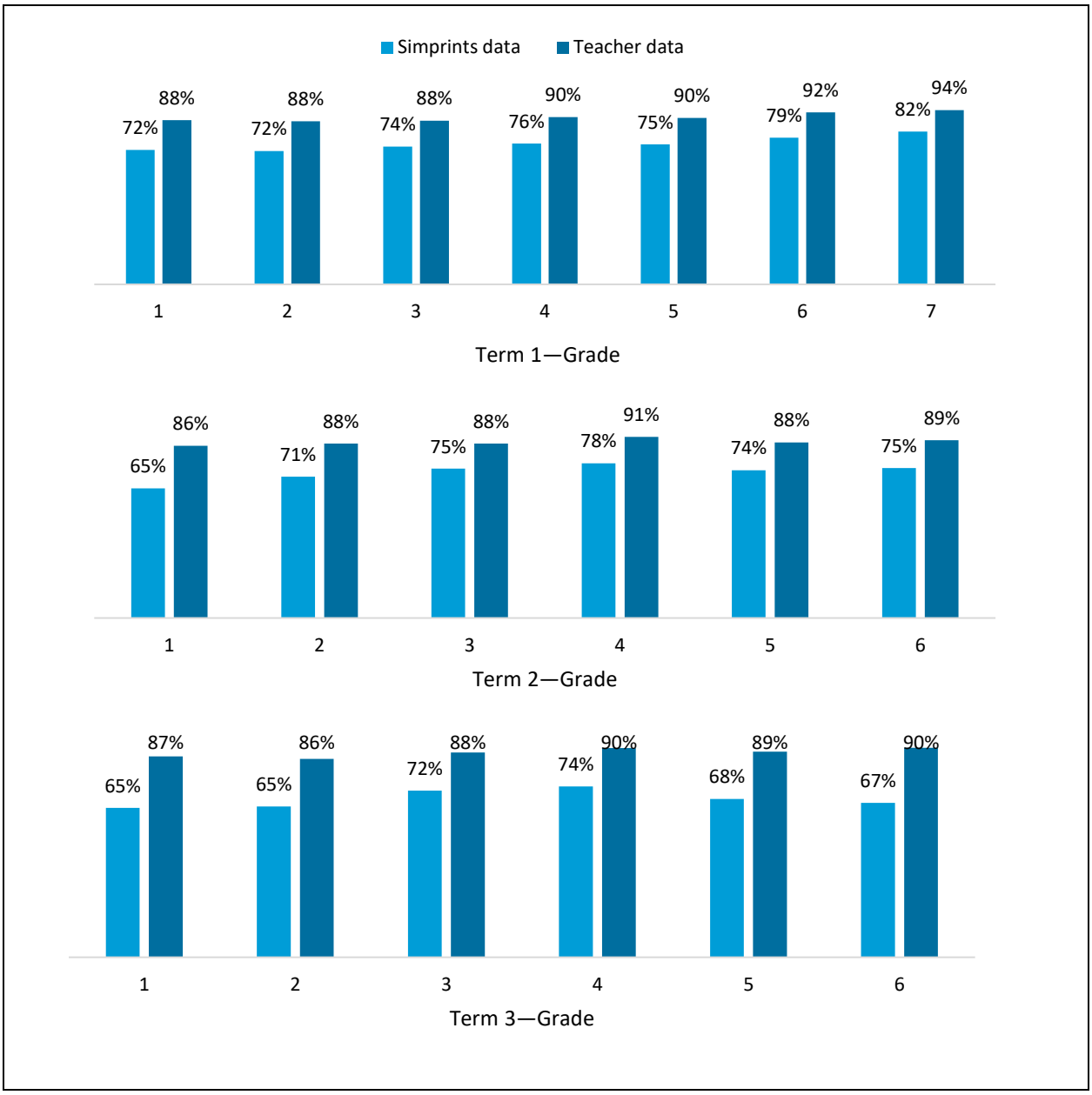
Similarly, students in FGDs noted that the manual method of calling out names and recording attendance on the paper register was prone to error. In their view, the biometrics system yielded a more reliable attendance record. One student explained, "If someone likes to be absent . . . the fingerprint shows because in the [manual] register . . . sometimes they forget that someone is absent." The student suggests that the paper register occasionally fails to record students who are absent, while biometrics is more accurate in showing these trends. In addition, a teacher from Mnyaula school suggested that the accuracy of the biometrics system was also important for teachers' attendance records, since school administrators could not falsely claim a teacher was absent if attendance was recorded via biometrics.

The limited accuracy of manual registers for attendance likely explains discrepancies in biometric and teacher-reported student attendance data revealed by the quantitative analysis. When comparing the biometric system and teacher-reported attendance, AIR found that attendance rates estimated from biometric-reported attendance data were lower than those from teacher-reported attendance data. Figure 2 shows term-wise attendance rates plotted from biometric-reported and teacher-reported attendance data for students who were enrolled in each term. The data included 2,352 students enrolled in Grades 1 through 7 in Term 1; 2,199 students enrolled in Grades 1 through 6 in Term 2; and 2,058 students enrolled in Grades 1 through 6 in Term 3.[11] Across all grades and terms, the data suggest that biometrics reported lower attendance rates compared with teacher-reported attendance, with a 14 percentage-point difference in Term 1, 15 percentage-point difference in Term 2, and a 20 percentage-point difference in Term 3. While in Terms 1 and 2, the difference between the two sources narrows down in higher grades, we do not see this pattern in Term 3. As stated above, respondents believed that the manual register was prone to error, which may explain the

[11] The Grade 7s are handled somewhat differently in the Impact Network data because 7seventh-graders write standard Grade 7 exams (and mock exams) during Terms 2 and 3. As a result, their data for Terms 2 and 3 are recorded separately and were not made available to us.

lower—and likely more accurate—attendance rates recorded by biometrics. However, it is also possible that lower attendance records are indicative of input errors, such as when teachers had to manually search for students' unique Impact Network IDs if the Vero scanner failed to read students' thumbprints. As we describe below, in all six observations of fingerprint scanning, at least one child's fingerprints were not immediately recognized by the scanner. In one case, nine children were not immediately recognized by the scanner. In these cases, teachers manually searched for students' Impact Network IDs.

Figure 2. Student Attendance Rates, by Term and Grade.



In addition, some teachers and Impact Network support staff believed that the biometrics system was more efficient and secure than the manual register. Some teachers stated that biometrics was a fast way of capturing attendance, despite the data we present below, which suggests that fingerprint scanning sometimes went beyond the expected time and became a potential disruption to instruction time (see "Operational Challenges," below). However, it is possible that the time it takes to scan fingerprints in the classroom varies by teacher. For instance, a teacher from Kanyelele school stated, "[The biometrics system] . . . saves time. [There is] no collecting papers, organizing things. You just open your phone." Another teacher, from Mkhazika school, noted that the biometrics system was a quick way to obtain data about attendance: "[Biometrics is] the quickest way to updat[e] each other. Each and every day, we can receive feedback." Variation in fingerprint scanning duration may also be related to teacher's experiences with the training—as noted above; while most teachers were satisfied with the trainings, two of the eight teachers interviewed for this study did not think that the trainings had adequately prepared them to operate the biometrics system.

Further, respondents felt that the biometrics system was a secure way to capture attendance data. They mentioned that biometrics data were stored on servers and were therefore less vulnerable to damage or loss when compared with paper data. For example, one teacher from Mkhakiza school stated, "[The manual register] can be eaten by termites. The phone cannot be eaten. We can also store that information for a longer period of time for specific pupils. . . . Some of the benefits are . . . we cannot lose information if you are using biometrics." In addition, one teacher from Mkale school noted that the biometrics system was very useful because "it's one way of keeping records safely."

Impact Network Staff and Teachers Believe that Biometrics Encourages Regular Attendance

Another success of the biometrics system is the enhanced capability of flagging students with problematic attendance records for follow-up services, which could lead to improvements in attendance rates at Impact Network schools. Previously, Impact Network staff did not have access to individual-level attendance data until teachers compiled it at the end of each semester. With biometrics, Impact Network staff were able to analyze student-level attendance trends on a weekly basis. While a lag exists in transferring data to teachers, many respondents felt that the biometrics system encouraged follow-ups with students who were recurrently absent.

Evidence about the occurrence of follow-ups is mixed. Impact Network support staff said there had been many follow-ups with positive results, and parents in the Impact Network sample described receiving visits. One Impact Network support staff explained how the biometric system has improved the follow-up process:

> First step for follow-up, teacher writes letter to guardian. Usually guardian responds by coming to school and explain why learner [is] not coming. If that isn't happening, a follow-up is made through school support officer and class teacher. . . . There have been a lot of follow-ups [because of Simprints] and many [students] showed [a] positive attitude towards school after.

However, few teachers described using attendance data to conduct follow-ups with absent students. In addition, two teachers interviewed during the first round of data collection had never received reports of student attendance data. Administrative staff mentioned that follow-up could be improved by providing more frequent feedback to teachers and designating another staff member to support follow-up services. Impact Network recently placed at each school support officers who were responsible for handling child protection cases and following up with absent students.

Teachers and Impact Network support staff felt that the biometric system encouraged students to attend class. According to Impact Network staff, teacher and student attendance rates have generally improved in schools implementing the biometric system. Further, several teachers stated that the biometric system reduced absenteeism among their students. However, teachers cited students' excitement about fingerprint scanning as the main mechanism of absenteeism reduction, rather than the occurrence of follow-ups based on biometric attendance data. For example, one teacher from Kanyelele explained that the biometric system made students excited to come to school. "[The biometrics system] reduces absenteeism. Because of this system, some learners who used to be absent a lot are eager to press their finger on the scanner. They feel good and interested because of the scanner, especially in the lower grades." Another teacher from Mkale school echoed this view, saying that the novelty of fingerprint scanning motivated students to come to school. "[The biometrics system is] useful for the teachers and learners as well. It motivates the learners to come to school, because the Vero and the phone, it's not common in the government school. So the learners are motivated to come to school." While our quantitative data do not allow us to estimate changes in attendance rates in schools implementing biometrics to track attendance, the lower attendance rates captured by biometrics may trigger follow-up services more often than the manual register.

Operational Challenges

We found the following operational challenges: (a) biometric fingerprint scanning with the Vero scanner took more time than expected, often because of unrecognized fingerprints; (b) devices were not always charged when needed, and/or lost charge quickly; (c) data were not easily

synced in areas with a spotty network; and (d) the system lacked a mechanism for disaggregating trend data.

Longer Scanning Time Was Required Because of Unrecognized Fingerprints

Classroom observation data suggested that fingerprint scanning with the Vero scanner often took longer than expected. According to Impact Network support staff, fingerprint scanning was expected to take 10 to 15 minutes. The six classroom observations showed a range of scanning time, from a little less than 10 minutes to more than 28 minutes. In two classroom observations, fingerprint scanning took considerably longer than the expected 10 to 15 minutes. While in one classroom, it took 28 minutes to scan 34 children (average time of 49 seconds per child), in another it took 19 minutes to scan 51 children (average of 22 seconds per child). In all six observations, at least one child's fingerprints were not immediately recognized by the scanner. In one case, nine children were not immediately recognized by the scanner. When fingerprints were not recognized, teachers recorded student attendance by manually searching for students' unique Impact Network IDs. Interviews with teachers and students confirmed our observation of variation in the time required to complete fingerprint scanning.

About half of the teachers interviewed for this study reported taking longer than the expected 10 to 15 minutes to take student attendance with the Vero scanner. For many of these teachers, the longer scanning time was because of the application's failure to recognize a high number of students' fingerprints. For instance, a teacher from Mkale school explained that fingerprint scanning time was a challenge, adding, "When the learner first starts the Vero, the name does not come out. They use the ID number. Most of the learners have that problem." Some teachers believed that scanning time was a problem particularly for lower grades, because younger children had more issues with unrecognized fingerprints. For example, one teacher explained,

> In the upper [grades] the children listen and they are cleaner in the hands and so on. But in the lower [grades] you will find the child has dirt. For the child to clean his thumb, for it to be clean, that is time going, and you will keep trying until at the end you will search using the ID, that is time.

According to Impact Network staff, failures to recognize students' fingerprints are likely related to the absence of registration of fingerprints for those students who were not present at the beginning of the school term (when registration usually happens). This suggests that more frequent updating of the system may help to decrease the incidence of unrecognized fingerprints.

Issues of fingerprint recognition were widespread among teachers interviewed for this study, even those who did not report problems with taking attendance through the Vero scanner in the expected 10 to 15 minutes. Seven of the eight teachers in our sample reported that they faced challenges because the children's fingerprints were not recognized by the biometrics system. For example, a teacher from Mkhazika school stated, "When there are issues [with the biometrics system], it is usually trouble reading the fingerprint." Some teachers described attempting to scan a students' fingerprints several times unsuccessfully before deciding to input the students' Impact Network ID directly into the biometrics application. For instance, another teacher from Mkale school noted, "When scanning a fingerprint, you find you can scan more than five times but the correct ID number won't reflect. . . . It just takes time to read the children's fingerprints." Other teachers reported experiencing challenges with fingerprint recognition with only a few students. A different teacher from Mkhazika school noted that dealing with unrecognized fingerprints was time-consuming, but it only happened with a few students.

> Sometimes you may try to capture attendance 2 to 3 times and then you start using the ID instead of the fingerprint. Sometimes you're trying to capture attendance using the finger, 2 to 3 times [and] then the name isn't matching with the correct name. . . . But this happens only for a few students.

Further, unrecognized fingerprints were also reported by students in FGDs. Some students stated that, although they were asked to clean their thumbs before using the scanner, their fingerprints were still not recognized.

Teachers noted that Impact Network staff suggested strategies to avoid taking away from class time, such as conducting some of the fingerprint scans while students were involved in classroom activities. However, it was unclear if these strategies were being implemented in the schools where we conducted classroom observations. None of the narratives or observations indicated that fingerprint scanning occurred while students engaged in other classroom activities.

Technical and Data-Related Challenges

We observed a series of technical and data-related challenges related to the operation of the fingerprint scanning system, including inconsistent charging, syncing difficulties, and lack of disaggregation capabilities. Qualitative data suggest that devices were not consistently charged when needed. Teachers are generally responsible for charging the Vero scanners and mobile phones. However, most teachers and Impact Network support staff interviewed for this study noted that Veros lost charge very quickly and had to be recharged during the school day, causing disruptions to the fingerprint scanning process. As a teacher from Mkhazika school explained,

> Some of the Veros, [when] you're in the process of capturing attendance, the battery [dies]. [The] Vero shuts down. That gives us problems. You have to connect it to a charger and the time is going. . . . Recharging isn't an issue, but it doesn't necessarily store power. . . . You put them for charging for hours and when you start capturing the attendance, it has a green color to say it's fully charged. But when you capture 5 pupils, the problem comes. If we can be provided with enough power storage, that will be helpful.

This finding was confirmed by data from FGDs. Students mentioned that uncharged devices were one of the main issues causing delays in fingerprint scanning.

In some schools, charging problems prompted teachers and support staff to rotate Veros among different teachers, so that some Veros could be charged while others were used to take attendance. In some cases, this resulted in teachers' experiencing a shortage of Veros when taking attendance in their classes. For example, a teacher from Kanyelele school noted that, when he had problems with Vero batteries dying, he "normally [waited] for another Vero from friends." Further, a few teachers explained that they occasionally experienced shortages in solar power because of weather, which disrupted the charging of biometrics devices.

In addition, the data collected through biometrics were not easily synced in areas with spotty network. According to a Simprints champion who supported the application in several Impact Network schools, data syncing was a problem for schools located in areas where the network didn't work well, and teacher supervisors or school support officers would sometimes have to take the phones to another location to sync. One school support officer described having problems with syncing but noted that he was able to resolve the situation with help from the Simprints champion.

Further, the biometrics system appeared to be limited in its ability to disaggregate trend data. Respondents noted that the biometrics attendance tracking system only produced data on overall attendance, without disaggregating by gender, age, or reason for absence (i.e., student was late or sick). According to Impact Network support staff and teachers, this kind of data disaggregation would help enhance the accuracy of biometrics attendance data and deepen understanding of attendance trends.

Limitations

While our study design has several limitations, we were able to obtain robust findings that provided information to address problems before scaling up the use of biometrics to track attendance in additional schools. Our qualitative sample is relatively small. As noted above, we

were unable to reach saturation during the first round and decided to expand our sample during the second round. However, due to travel restrictions during the COVID-19 pandemic, we only conducted additional key informant interviews remotely. Specifically, we were only able to interview two administrative staff members during the second round of data collection because of turnover within Impact Network. While we determined that it was appropriate to conduct interviews over the phone with teachers and Impact Network support staff, we did not think it would be feasible to conduct focus groups with children or classroom observations remotely. For this reason, our qualitative sample size for classroom observations and student FGDs remains small. Since we did not have an opportunity to observe the use of biometrics to track attendance across a wide variety of schools and grades, our perspective of the operation of the fingerprinting technology is somewhat limited. While we were unable to expand the sample size for FGDs and classroom observations, we believe that we reached saturation through the additional KIIs, as researchers heard similar themes emerging from interviews across respondents and schools during the second round.

In addition, the second round of data collection may be subject to recall bias. Six teacher KIIs, two Impact Network support staff KIIs, and two Impact Network administrative staff KIIs were conducted after schools had been closed for several months because of the COVID-19 pandemic. As a result, teachers and support/administrative staff interviewed in the second round reported on their experiences using biometrics to track attendance from several months before. However, findings from the second round of research were generally consistent with those from the first round, suggesting that recall bias did not affect our sample enough to invalidate our results.

We also encountered a few challenges associated with remote data collection during the second round. We conducted interviews by calling respondents by phone. Some interviewees had poor network reception since they were based in rural areas and calls dropped from time to time. However, researchers persistently followed up with respondents to ensure that they received all the necessary information.

Further, while analyzing student attendance from two different sources can offer some evidence of data quality and mismatch between biometric-reported and teacher self-reported student attendance data, we need to exercise caution in interpreting these results. Specifically, the analysis cannot address whether the use of biometrics to track attendance led to changes in attendance because we are unable to verify the accuracy of either source.

Recommendations

Based on these findings, AIR developed the following recommendations for Impact Network schools:

- **Impact Network should develop strategies to ensure that the use of the fingerprinting technology does not take away from instructional time.** While the technology (i.e., the Vero scanners) was developed for contexts in which people have cracked and/or dry hands, interviews and observation data suggested children's fingerprints were unrecognized often enough to delay the scanning process and potentially take away from instruction time. According to Impact Network staff, this may be because fingerprints of students who were absent at the beginning of the school term were not registered in the system. We recommend that Impact Network explore strategies to decrease the incidence of unrecognized fingerprints (such as registering new students in the biometric system more frequently) and develop a protocol to speed up the switch from scanning to searching the Impact Network ID in case the application fails to recognize a student's fingerprint. In the meantime, Impact Network should work closely with teachers to ensure that students are engaged in other activities like reviewing their notes when fingerprint scanning is taking place.
- **Impact Network should consider providing incentives for teachers to conduct follow-up visits with absentee students based on attendance data and develop a monitoring mechanism to track whether follow-up visits are occurring with absentee students.** While most teachers reported receiving attendance data, the evidence that these data are used to conduct follow-ups is mixed. Teachers noted that the regular attendance data were useful to identify students requiring follow-up, but students and teachers did not indicate that follow-ups were happening consistently with students who were flagged as absentee in attendance data. Providing incentives for teachers and monitoring the occurrence of follow-ups could help maximize the use of attendance data and increase teacher accountability to school administrators for conducting follow-ups with absentee students. Determining the type of incentives that are effective will likely require some more investigation.
- **Impact Network should create a functionality to incorporate gender information and "reason for absence" into attendance data.** Impact Network staff and teachers agreed that gender disaggregation would improve understanding of differential attendance trends between boys and girls. Further, there was general agreement that including granularity in the "absent" category—including illness, tardiness, or transfer—would enable schools to better identify and address attendance trends. For example, Impact Network could consider adding a module to the attendance tracking system that lists students whose fingerprints were not scanned on a given day and allows teachers to list the reason for absence (if known). This information could be incorporated in the attendance data that teachers receive and help inform follow up visits.

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