Education Sector

United Nations
Educational, Scientific and
Cultural Organization

05

Working Papers on Education Policy

Re-orienting Education Management Information Systems (EMIS) towards inclusive and equitable quality education and lifelong learning

Education 2030

Re-orienting Education Management Information Systems (EMIS) towards inclusive and equitable quality education and lifelong learning

UNESCO Education Sector

Education is UNESCO's top priority because it is a basic human right and the foundation on which to build peace and drive sustainable development. UNESCO is the United Nations' specialized agency for education and the Education Sector provides global and regional leadership in education, strengthens national education systems and responds to contemporary global challenges through education with a special focus on gender equality and Africa.

The Global Education 2030 Agenda

UNESCO, as the United Nations' specialized agency for education, is entrusted to lead and coordinate the Education 2030 Agenda, which is part of a global movement to eradicate poverty through 17 Sustainable Development Goals by 2030. Education, essential to achieve all of these goals, has its own dedicated Goal 4, which aims to ***"ensure inclusive and equitable quality education and promote lifelong learning opportunities for all."*** The Education 2030 Framework for Action provides guidance for the implementation of this ambitious goal and commitments.

United Nations
Educational, Scientific and
Cultural Organization

Education
Sector

Education 2030

Published in 2018 by the United Nations Educational, Scientific and Cultural Organization, 7, place de Fontenoy, 75352 Paris 07 SP, France

DMS: ED-2018/WS/11

This paper belongs to a series which is designed to nurture the international debate about a wide range of education policy issues.

More details about the series of UNESCO Working Papers on Education Policy can be obtained from:

Francesc Pedró
Education Policy
UNESCO Education Sector
Email: f.pedro@unesco.org
https://en.unesco.org/themes/education-policy-planning/

Designed and printed by UNESCO

Printed in France

Table of contents

Acknowledgements

This Working Paper was produced by the Division for Policies and Lifelong Learning Systems in UNESCO's Education Sector. It was drafted by Miguel Subosa with Mark West's contributions to the Introduction and Section IV. Keith Holmes and Francesc Pedró provided overall guidance and supervision.

The paper also benefited from the inputs of the following UNESCO experts: Sara Bin Mahfooz, Borhene Chakroun, Amélie Gagnon (UNESCO-IIEP), Astrid Gillet, Faryal Khan, Jean Bosco Ki, Tun Lwin, Yukiko Matsuyoshi, Hilaire Mputu, Tap Raj Pant, Shailendra Sigdel, Sobhi Tawil, Megumi Watanabe, and Satoko Yano.

Abstract

This Working Paper provides conceptual frameworks and strategies to help countries re-orient their Education Management Information Systems (EMIS) to support inclusive and equitable quality education and lifelong learning opportunities for all, in line with Sustainable Development Goal 4 (SDG 4). It emphasizes the potential of EMIS to support the implementation of SDG 4 at the national, state, local and classroom levels.

The paper first outlines how new international priorities for education — especially the focus on learning outcomes and learning across life in formal, non-formal and informal contexts — have placed new demands on EMIS. It posits that, going forward, EMIS should collect an expanded range of actionable data to both improve teaching and learning and provide insights into how education can be linked with different sectors to advance a wider range of development objectives. The paper recommends that countries work to strengthen EMIS in at least four functional domains: management and administration; planning; policy formulation; and monitoring and evaluation.

After establishing the need for robust data systems to support progress towards SDG 4 and the wider 2030 Agenda for Sustainable Development, the paper looks specifically at strategies to build technical tools; human resource capacities; and policies, plans, and institutional arrangements to support the development of EMIS.

Case studies provide practical illustrations of how UNESCO is working with its Member States to reinforce data gathering capacities and leverage existing systems to inform and steer education reform.

Finally, the paper reflects on future directions for EMIS, drawing attention to opportunities and challenges likely to emerge in the decade ahead.

Introduction

In 2015, the United Nations General Assembly agreed to pursue 17 Sustainable Development Goals (SDGs) to achieve peace and shared prosperity by 2030. SDG 4 speaks specifically to the importance of education and commits countries to work towards 'inclusive and equitable quality education and promote lifelong learning opportunities for all'.

Seven outcome targets and three means of implementation underlie the overarching commitment to education and represent a significant departure for earlier international goals for education. The SDG 4 agenda is holistic and broader in scope, has a wider policy focus, pursues qualitative as well as quantitative targets, and is universal in terms of geographic coverage (UNESCO, 2017).

Countries at all levels of development are now faced with the challenge of aligning their education policies and systems with the new agenda and accelerating progress towards its targets. Data are essential to this process; they enable an understanding of which goals are being met and, more vitally, how goals might be achieved more effectively.

EMIS are the tools countries use to gather, process and interpret data. For the past several decades, these systems have grown in complexity to give policy-makers and classroom teachers alike a view of whether learners, schools, and national education plans are progressing in relation to different objectives. The systems underlie education reforms and form the backbone of monitoring and evaluation efforts.

To fully achieve SDG 4, EMIS must be oriented towards the new targets and means of implementation. This is a significant undertaking: SDG 4 privileges 'learning' over 'education' by placing learning along a lifelong cradle-to-grave continuum. It also emphasizes targets that do not necessarily have easily quantitative indicators, including ensuring expanded and equitable access to all forms of post-basic education and training (Target 4.3); relevant skills for the world of work (Target 4.4); relevant learning for citizenship in a global world (Target 4.7); safe and inclusive learning environments (Target 4.a); and adequate teacher recruitment, training and professional (Target 4.c).

The question that this paper explores is: How can countries re-orient EMIS to help them achieve SDG 4?

The paper also looks at what the 'integrated' and 'indivisible' nature of SDG 4 means for EMIS. Education is fundamental to the attainment of all 17 SDGs, and if EMIS are to truly align with SDG 4 at a country level, they must recognize the interconnectedness of various development vectors, as well as consider education along a lifelong learning continuum. Apart from SDG 4, education is explicitly mentioned in five other SDGs, from health and well-being (SDG 3) to climate change mitigation (SDG 13). EMIS need to draw data from sources outside formal educational institutions, such as household surveys, labour market information systems, and health information systems in order to clarify the ways education is (and is not) supporting the full Agenda for Sustainable Development and how it might do so more effectively. For this reason, previously narrow conceptions of EMIS and educational data in general must be updated for countries to be able to track their progress towards SDG 4 as well as act on this information by implementing policies and programmes that accelerate progress.

Country case studies, summarized in the paper and contained full in the appendices, illustrate how UNESCO is supporting its Member States in the deployment and use of EMIS. The paper is addressed to governments, education stakeholders, and development partners working to make EMIS enablers of inclusive and equitable quality education and lifelong learning for all. UNESCO is in a strong position to steer this dialogue, given its role as the agency mandated to lead and monitor the implementation of SDG 4.

UNESCO's experience in providing policy advice and technical support to ministries of education makes it uniquely able to contextualize EMIS to the varied needs and contexts of different countries. The Organization is also well-placed to guide countries in identifying, collecting, and reporting the most relevant data needed to achieve SDG 4 targets. The analysis in this paper draws on UNESCO's experiences in providing EMIS-related support to its Member States.

The paper has four sections. Section I presents previous conceptions and definitions of EMIS and critically examines them in terms of how adequately they are able to respond to the data demands of SDG 4. It also illustrates the data gaps that need to be bridged by countries to effectively track their progress and advance progress towards SDG 4 targets. Section II introduces frameworks to help assess EMIS effectiveness and considers these frameworks vis-à-vis the data priorities of SDG 4. Section III discusses how EMIS could be further strengthened to facilitate the more complex data collection required of SDG 4, with reference to technical capacities, human resources, and plans, policies, and institutional arrangements. Finally, Section IV discusses possible future directions for EMIS in the light of the 2030 Agenda for Sustainable Development, its wide scope, and interconnectedness. The section also considers how countries might leverage emerging technological developments to augment EMIS capabilities.

Section I

Evolving conceptions of EMIS

In response to the adoption of SDG 4, there is a growing call for education policy to turn to the equity, inclusiveness, quality and relevance of education systems, and their outputs and outcomes.

Governments are increasingly recognizing that as a human right education not only has intrinsic value in itself, but facilitates the attainment of other development objectives, such as alleviating poverty, improving public health, and decent employment. At the international level, this realization is illustrated by the discursive shift in education agendas between Millennium Development Goal 2 (MDG 2) and SDG 4. SDG 4 goes beyond an 'access' agenda by putting an emphasis on equity, inclusiveness, quality, and the relevance of education throughout life. SDG 4's scope includes all forms of education from early childhood to the senior years. This is apparent in the respective targets and indicators for MDG 2 and SDG 4.

MDG 2 included only one target: "Ensure that, by 2015, children everywhere, boys and girls alike, will be able to complete a full course of primary schooling." Three indicators were used to measure progress towards this target:

- Net enrolment ratio in primary education
- Proportion of pupils starting Grade 1 who reach the last grade of primary school
- Literacy rate of 15–24-year-olds, women and men

By contrast SDG 4 looks at education along a lifelong learning continuum, encompassing early childhood development (Target 4.2), primary and secondary education (Target 4.1), technical, vocational, and tertiary education (Target 4.3), and workplace skills and entrepreneurship (Target 4.4). Moreover, SDG 4 includes targets that impact on or interface with targets set by other SDGs. For instance, Target 4.4 emphasizes the role of education in building the skills and competencies of youth and adults to enable their attainment of just and gainful employment. Target 4.7 calls for education systems that "promote sustainable development, including among others through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship, and appreciation of cultural diversity, and of culture's contribution to sustainable development" (UNESCO, 2017).

The broadened scope of SDG 4 within the 2030 Agenda requires EMIS that go far beyond administrative data towards data that can inform policies and plans for longer-term educational outcomes. EMIS should also examine the relationship of educational outcomes with other sectors of socio-economic development, such as poverty alleviation, health, and employment. Furthermore, while simple metrics such as enrolment, attendance, and grade completion show access and participation in education, they do not provide guidance related to the quality or relevance of the education, the extent to which it is equitable and inclusive, and what learning is taking place.

Accordingly, developing EMIS must now go far beyond selecting, operating and updating relevant software. It must also involve the right combination of vision, technical capacities, human resources, and social processes needed to meet expanded data demands and provide superior information to decision-makers working in changing technological and policy contexts.

SDG 4 is therefore a reason and cause to re-examine the types of data used by EMIS and to re-assess if these data correspond adequately with the needs of the range of users, whether from local, national, regional, or international perspectives. It is imperative to not only expand the coverage of educational data to different types and levels of education and lifelong learning, and to be able to monitor inclusion and equity, but also to analyse and understand educational data as it relates to other vectors of socio-economic development.

A. Defining EMIS

This paper understands EMIS as the ensemble of operational processes, increasingly supported by digital technology, that enable the collection, aggregation, analysis, and use of data and information in education, including for management and administration, planning, policy formulation, and monitoring and evaluation (M&E). This definition insists on the systemic nature of EMIS — a fact which is often overlooked in efforts to reinforce government information systems.

EMIS are frequently thought of as specialized units responsible for data collection, compilation and dissemination to decision-makers, and for planning and reporting purposes. Hua and Herstein (2003, p. 4), for instance, describe EMIS as "an institutional service unit producing, managing, and disseminating educational data and information" whose uses include "collecting, storing, integrating, processing, organizing, outputting, and

marketing educational data and statistics in a timely and reliable fashion."

However, EMIS are better understood as system-wide, and not units exclusively located in one place. The collection, input and analysis, and use of data is a collective endeavor — that is, beyond the work of any particular unit, team, or service — that informs administrative, managerial, planning, and policy decisions horizontally across the entire education system, within and between subsectors and institutions.

Formal education systems developed EMIS with the purpose of managing resources (human, material, and financial). In the 1980s, when information management systems were beginning to be computerized, the digitization of EMIS was motivated by a desire to automate routine administrative functions (Cassidy, 2006). Since then EMIS has often focused on administrative data such as enrolment rates, schools, and number of teachers (Powell, 2006). This partly explains why, today, EMIS are sometimes narrowly understood as technical tools, pieces of information management software, rather than a social process, and an integral and evolving part of education system reforms. Cassidy (2006), for instance, describes how:

> **[f]or some people, any effort to improve the quality of data and information is associated with EMIS. For some, an EMIS is simply an updated, computerized, statistical information system. Others refer to any administrative, function-specific database system as an EMIS, e.g., personnel management systems, financial management systems, project monitoring systems, municipal education database systems, etc. For some, EMIS is all about computers and computerization.**

On the other hand, Abdul-Hamid, Saraogi, and Mintz (2017, p. 1) lay out a systemic, albeit very fundamental definition for EMIS: 'In its simplest form, [it] can be defined as a system responsible for collection, maintenance, analysis, dissemination, and utilization of data in an education system.' While this definition certainly captures the systemic nature of EMIS, it is rather general, and does not identify the elements that constitute the system.

Villanueva (2003, p. 5) proposes a definition that acknowledges EMIS as a system – describing it as 'a tool that uses systems theory':

> **It is a collection of component parts that include inputs, processes, outputs, and feedbacks that are integrated to achieve a specific objective. It is a system for managing a large body of data and information that can be readily retrieved, processed, analyzed, and made available for use and dissemination.**

Villanueva also touches on the technology component of EMIS, highlighting how "developments in computerization" help "create a comprehensive approach to the collection and use of vast quantities of information on the education and training system" (p. 5). UNESCO-IIEP enumerates the following as the specific components of an EMIS: "people, technology, models, methods, processes, procedures, rules, and regulations".

The guiding vision for the development of EMIS was, according to Tung (2003), "to establish a demand responsive and self-sustainable" system that is based on the integration of decentralized and distributed sub-systems; guided by a partnership of stakeholders; and supported by technically competent bodies (Tung, 2003).

EMIS can thus support system-wide efforts to improve the equity, inclusiveness, and quality of education and learning: to prepare learners, create better learning environments, make content more relevant, augment the competencies of teachers, and increase the linkage between student learning and positive participation in society (Abdul-Hamid, 2014). In the context of SDG 4-Education 2030, EMIS can, for example, advance a rights-based approach to education by providing evidence of the extent to which individuals do — or do not — enjoy their right to education. Information about access, participation, equity, quality and relevance is necessary to ensure that no one is left behind.

B. Expanding the range and kinds of data covered by EMIS

Typically, EMIS aim to generate reliable information in a timely, cost-effective, and sustainable manner. A comprehensive education management information system aims to help integrate previously fragmented data from across subsectors, levels, and types of education. From the outset, the development of EMIS was "based on the idea that the Ministry of Education's (MoE's) information requirements needed to be considered from a wider perspective, one that involved acquiring both quantitative and qualitative information for educational policy, planning and implementation" (Wako, 2003. p. 15).

A well-functioning system is able to answer a wide range of questions raised by educational stakeholders. These questions range from addressing planning and budgeting, to staffing and management issues, to institutional and system performance, to education policies and strategies, to international reporting and cooperation. A

comprehensive education management information system should make it easier for stakeholders to find or request information and address relations and transitions between various types and levels of education. Often this not only means going beyond providing the facts but also analysing, interpreting and facilitating knowledge-sharing and policy dialogue.

The technical and human challenges for developing integrated EMIS are significant; to be effective and to provide stakeholders with comprehensive information, EMIS need to use, and integrate, different data sets coming from diverse sources. In the best case scenario, EMIS would work on data inputs, processes, and outputs at the different levels and modalities of educational provision with a high degree of granularity — i.e. from aggregated data at national level to the detail of a particular school, classroom or even of the individual student (while recognizing privacy concerns). Under this scenario, all the key actors, activities, and the supporting resources that are required for the provision of education at all levels and modalities would contribute to and benefit from EMIS.

However, considering that multiple ministries of government and, increasingly, for-profit and not-for-profit private providers are involved in education, the development of EMIS cannot be left to ministries of education alone.

Due to the evolution of EMIS, data are typically collected separately on each of the subsectors of education and training. This may, however, change in the future as the interconnection and transitions between subsectors becomes more important. Furthermore, education stakeholders will increasingly be asking questions about the equity and relevance of educational opportunities and outcomes, for the advancement of quality education and lifelong learning and, more broadly, for the SDGs.

The educational data currently being collected by Member States are insufficient and do not cover the full range of data needed to monitor progress towards SDG 4. While MDG 2 focused on universal access to basic education and ensuring gender parity in education, SDG 4 is broader, expanding to lifelong learning with a shift in focus from "schooling" to "learning", as well as a redefinition of what a "learner" is.

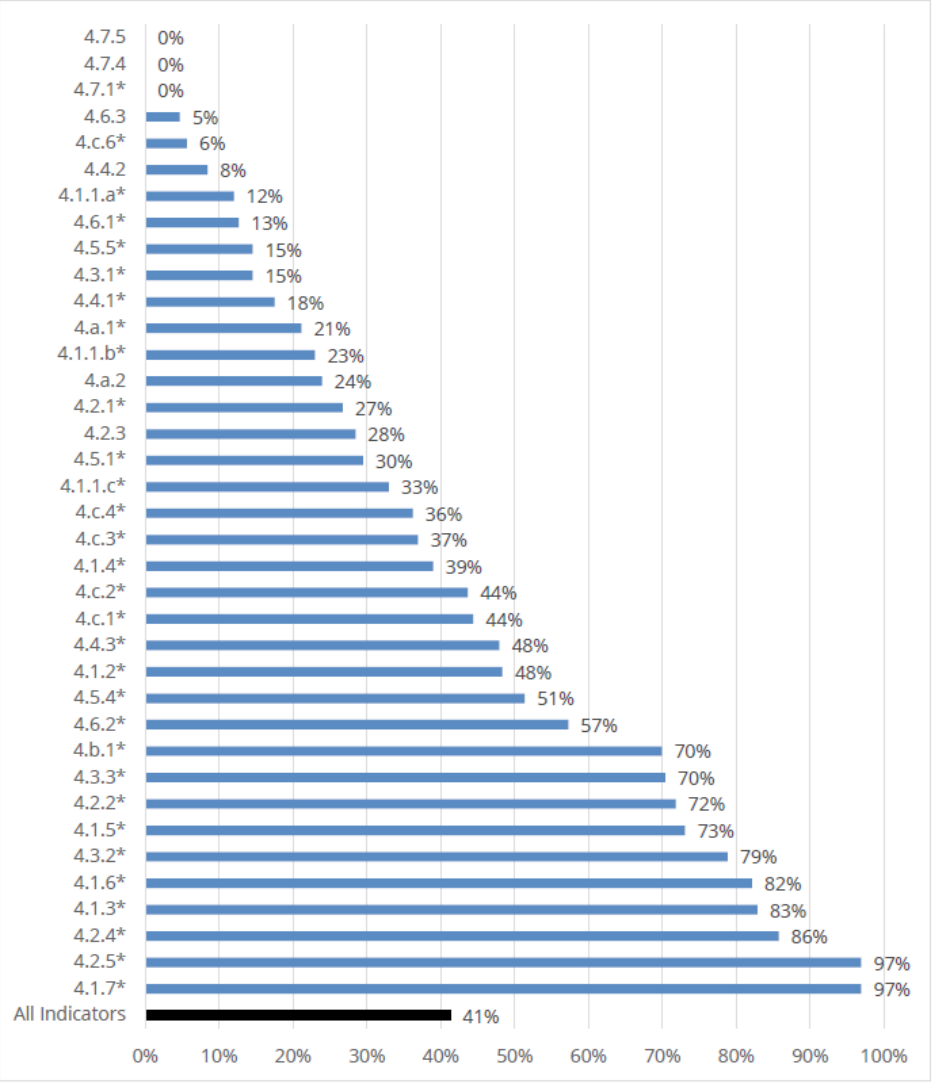
At the same time, SDG 4 concerns itself with inclusion and equity in education not only in terms of gender equality but also for disadvantaged groups such as persons with disabilities, indigenous peoples, and children in vulnerable situations, among others. SDG 4 hence poses more complex data demands than MDG 2 as it goes beyond access to education to focus on quality of education, and given its emphasis on the role of education in helping countries progress towards the other SDGs (UNESCO, 2017).

The UNESCO Institute for Statistics (UIS, 2018a) reports the rate of coverage for each indicator.[1] Figure 1 shows huge gaps in terms of the data currently available and the data needed to monitor the attainment of SDG 4 targets. Indicators related to the promotion of sustainable development and global citizenship (Target 4.7) are still virtually uncovered in national data. There is also very limited data coverage of literacy and numeracy outcomes, linked with indicators such as 4.4.2, 4.6.1, and 4.6.3. On the other hand, indicators with the most data coverage are those that pertain to enrolment and completion rates, such as Indicators 4.1.3, 4.1.6, 4.1.7, 4.2.4, and 4.3.2.

This reinforces the need to re-orient EMIS towards educational outputs and outcomes (rather than inputs) and intersectoral analyses (rather than just analysing educational data in isolation of other socio-economic outcomes). This also poses the challenge of complementing quantitative data with qualitative data. For example, the mainstreaming of sustainable development and global citizenship education in school curricula is one such target that cannot be adequately measured by solely quantitative data. The list of all SDG 4 targets and indicators are provided in **Appendix A**.

1 According to UIS (2018a), 'the rate of coverage for each indicator [is] based on the numbers of countries in each region where the indicator has at least one variable data point between 2010 and 2016. If an indicator has several components, the rate of coverage is based on the combined rates for the components. The data presented here are based on the latest UIS education data release of June 2017 and presented by source of information.'

Figure 1. Gaps in educational data coverage with respect to SDG 4 indicators [2]



Key data on all levels of education and training are needed, and these can be organized according to inputs, processes, and outcomes. The collection of data should be informed by the expected demand, based on past requests for information from different stakeholders and reporting obligations at various levels. As such, the broadened scope of SDG 4 would require data on education and training through the lifetime, as opposed to only basic education, which was the focus of MDG2-EFA.

This means that longitudinal data become necessary, in order for EMIS to effectively address the demands of SDG 4. These longitudinal data also do not necessarily need to come exclusively from the education sector, EMIS can also draw data from other information systems. For instance, EMIS can interface with health information systems to examine relationships between education-related and health-related variables, helping explain questions such as how women's education influences child survival or mortality in developing countries (Cleland & Van Ginneken, 1988; Desai & Alva, 1998; Chen & Li, 2009), or determining the extent to which the mainstreaming of sexuality education contributes to HIV/AIDS prevention efforts (Kirby, Obasi, & Laris, 2006; Fonner et al., 2014). In terms of decent and productive work, EMIS can help determine the effectiveness of school-to-work transition programmes in providing decent work for youth (Sparreboom & Staneva, 2014) or measure the adequacy of adult skills vis-à-vis labour market demands and the ability of education systems to augment those skills (Kenn, 2016).

Beyond basic statistics on admissions and registrations, stakeholders also need information on what is being learned by age, gender, and other demographic data. To assess inequalities over time, data that can be used to understand the level of educational disadvantage experienced by specific vulnerable and marginalized groups are much needed. However, UIS (2018a) similarly reports sectoral data gaps, with very little usable data existing for adult education and non-formal education. Even for the subsectors covered by MDG 2 — that is, primary and general secondary education — there is also limited coverage of outcome-based data (see Figure 2).

2 Source: UNESCO Institute for Statistics (2018). Concept Note: The Investment Case for SDG 4 Data. Dubai: UNESCO

Figure 2. Sectoral data gaps[3]

	Enrolment	Graduates	Teacher's count	Tearcher's training	Government expenditure	Household expenditure	Learning outcomes/skills assessment	Other surveys
Early childhood care and education		N/A						
Primary education								
General secondary education								
Formal TVET								
Non-formal TVET								
Formal adult education								
Non-formal adult education								
Tertiary education								

- Data exist, usable, well defined, accessible and with very good coverage
- Data exist, usable, well defined, accessible and with good coverage
- Data exist, usable, well defined but would need extra efforts to compile nationally and report internationally
- Some data exist but with litmited coverage/quality/usability
- No data/problematic data/require major developments and ressources

At present, information on disadvantaged and vulnerable groups also tend to be incomplete, or at worse, absent. For instance, UNICEF (2016) reports that 19 out of the 40 countries it surveyed in its guidance note for the inclusion of disability in EMIS, had virtually no data on children with disabilities; for countries surveyed that had data on disability, many only indicated that the child was on a special needs programme, but did not specify the disability. This lack of data renders the experiences of persons with disabilities invisible, and it could inhibit progress towards SDG Target 4.5, to eliminate disparities linked to all forms of vulnerability and marginalization.

Currently, data collection takes place primarily within educational institutions and programmes. However, demographic and household data can also be included in an education management information system. As education agendas have evolved, so have the demands for data. For instance, data on the health and psychosocial well-being of children under five years of age (Indicators 4.2.1 and 4.2.3) will not always be obtainable from formal educational institutions, but could potentially be extracted from household surveys. The same could be said for data on participation in non-formal education and training and for data on out-of-school children.

Information needs do, however, vary according to the roles of stakeholders throughout education and training systems. A recurring challenge for EMIS is collecting data that meet the needs of a diverse range of stakeholders within and between countries.

At the class or programme level, teaching staff need information about national education objectives, school attendance, and student achievement. School head teachers need information on students, teachers, historical class results, and staff development needs. Educational administrators, whether at district or national level, need information — preferably time series data — on demography, admissions, staffing, infrastructure, and school resources. Financial data are especially important to inform decisions about budgets, resource mobilization, and allocations. Across the various subsectors of education and training, information may be useful for management and administration, for planning, for the formulation of education policy, and for monitoring and evaluation. The following are examples of questions that could be asked of EMIS.

From a management and administration perspective…

1. What proportion of schools do not have a reliable source of electricity?
2. What is the rate of student absenteeism in specific schools?
3. What are professional development opportunities available to teachers?
4. What competencies do existing teachers have, and do those competencies satisfy student learning needs?

3 Source: UNESCO Institute for Statistics (2018). Concept Note: *The Investment Case for SDG 4 Data*. Dubai: UNESCO.

5 Do schools have a sufficient number of pedagogical materials, such as textbooks, vis-à-vis the number of enrolled students?

From a planning perspective…

1 How many additional teachers are required to achieve universal secondary education?
2 How much budget must be allocated to the improvement of school infrastructure in a certain district or province?
3 What proportion of households have ready and affordable access to ECCE services?
4 What is the average student-teacher ratio in primary schools, and how conducive is this to learning?
5 What proportion of the students completing secondary school enrol in higher education institutions (HEIs)

From a policy formulation perspective…

1 What incentives can retain qualified teachers in remote schools?
2 What is the completion rate of students in primary education?
3 How do socioeconomic factors affect rates of dropout and absenteeism?
4 How responsive is the current curriculum to labour market needs?
5 How does the academic achievement of boys in primary education compare to that of girls in primary education?

From a monitoring and evaluation perspective…

1 Is gender parity in access to secondary education improving over time?
2 What is the employment rate among alumni of technical and vocational education and training (TVET) programs?
3 Are disparities in adult literacy rates across the country decreasing over time?
4 How have pedagogical reforms influenced student achievement in the country?
5 How effective has the use of technology for pedagogy been in improving student learning outcomes?

It is clearly essential for data sets to be interconnected so that decision-makers at all levels can see the education and training system as a whole and as part of wider society and economy. Demographic data, on fertility and migration for example, have significant implications for management and administration, planning, policy formulation, and monitoring and evaluation. Data on labour market trends and specific economic sectors can also be informative in efforts to ensure that education and lifelong learning contribute towards inclusive and sustainable development.

In consequence, standards for data must be developed within and beyond the education sector so that different entities can input appropriate and relevant data into the system. To give a specific example, the education management information system in Afghanistan includes several components that are now being more closely integrated.[4] As these components are not limited to any subsector of education and training it would be possible, in theory at least, to extend them to cover additional levels or types of education, such as ECCE and higher education (HE). According to de Silva and Valsangkar (2015), Afghanistan "is an excellent example of how IT has transformed the management of education despite many obstacles to success."

Box 1. EMIS in Afghanistan

The **Student Management System** provides details regarding students, their demographic data, class status, and more. Each student is mapped to a school and each school is identified by a unique code. An attempt is underway to identify each student in any given school through the use of a unique ID.

The **Teacher Management Information System** tracks the induction, training and professional development of teachers. This allows the Ministry to develop needs-based career development programs for teachers. It is a critical intervention in an environment where nearly 30 percent of teachers lack proper qualifications.

The **School Management System** provides details of all schools location, type of school, number of classrooms, toilets, library, science labs, etc.

An independent **Infrastructure Management Information System** currently being developed computerizes all stages of infrastructure development.

The **Asset Management System** monitors the operations and maintenance information of all the infrastructure assets in the country. These three systems together allow Ministry leadership to easily identify infrastructure gaps and track the installation, usage and maintenance of all school infrastructure in the country.

The first ever **national learning assessment** for students is being done using tests specially configured for computing tablets. Once the tests are completed test results are transferred and computed on standardized computing platforms in real time.

Today's **Certificate Distribution System** allows the Ministry to easily identify authentic students registered in the system and distribute school leaving certificates only to them.

The **Human Resource Management Information System** was developed to manage the entire work cycle of the hundreds of thousands of Technical Assistants working in the Ministry including their selection, induction, performance assessment, payment and promotion.

4 http://blogs.worldbank.org/education/impact-education-management-information-systems-case-afghanistan

At the international level, regional and international stakeholders typically require education data suitable for cross-national comparisons. The data collected by the EMIS should thus meet nationally specific information needs and those which are of interest internationally. For example, data are needed for reporting on the State's obligations under international normative instruments that it has ratified, as well as under other international recommendations and declarations. For example, the monitoring of the right to education would include information relevant to Article 26 of the 1948 Universal Declaration of Human Rights, the 1960 Convention against discrimination in education, and other standard setting instruments in the field of education.

Box 2. Article 26 of the 1948 Universal Declaration of Human Rights

- Everyone has the right to education. Education shall be free, at least in the elementary and fundamental stages. Elementary education shall be compulsory. Technical and professional education shall be made generally available and higher education shall be equally accessible to all on the basis of merit.
- Education shall be directed to the full development of the human personality and to the strengthening of respect for human rights and fundamental freedoms. It shall promote understanding, tolerance and friendship among all nations, racial or religious groups, and shall further the activities of the United Nations for the maintenance of peace.
- Parents have a prior right to choose the kind of education that shall be given to their children.

As noted, in the context of SDG 4, attention is turning to learning pathways, transitions between education levels, and types of learning (for example, between non-formal and formal education), and transitions between education and the world of work. However, this creates real challenges due to different understandings of key concepts and categories, such as "literacy" or "skills." Where education and training systems have profoundly different histories and architectures, great care is needed in the interpretation of data gathered on different subsectors.

This has become especially important now that there is increased attention to learning outcomes and their relevance for individuals and the development of their communities. While large-scale learning assessments are one way of measuring learning outcomes, they often overemphasize academic results and tend to neglect social dimensions of learning. In a high-level panel on SDG 4-Education 2030, held in Paris on 1 November 2017, the representative of Bolivia referred to the need for a "social evaluation" of education.[5] There could now be a need for data on how happy and satisfied people are with education in their locality, region, or be country. Data are needed on the full range of educational outcomes, "such as the emotional well-being of individual learners, as well as collective outcomes, such as social cohesion." Although few EMIS, if any at all, have started to collect data on the wider benefits of learning in a systematic way, such data could help support national reporting on progress against the targets of the 2030 Agenda and prompt the implementation of policies and programmes that accelerate that progress.

Given UNESCO's role in setting, enforcing, and monitoring norms and standards in education policy, as well as its position as the agency in charge of SDG 4-Education 2030, the Organization is well suited to steer the dialogues and initiatives in reconceptualizing and re-orienting EMIS towards SDG 4 and the broader Agenda for Sustainable Development. Moreover, UNESCO serves as the primary platform by which education stakeholders from different Member States can communicate, share knowledge, and forge regional and international alliances.

5 http://unesdoc.unesco.org/images/0026/002601/260175e.pdf

Section II

Effective EMIS for the Sustainable Development Agenda

Effective EMIS provide valuable data that inform processes of a) management and administration, b) planning, c) policy formulation, and d) monitoring and evaluation. These processes are interconnected and take place at various locations in education systems, from central to local, and within education institutions themselves. This section looks at the potential contributions of EMIS to each of these processes of education system development.

A. Management and administration

EMIS provides support not only to the delivery of educational services, but also to the fulfilment of managerial functions (World Bank, 2016) in the wider context of results-based management. The monitoring of routine administrative functions, tracking and approval of financial transactions, timekeeping, or maintaining personnel records can be greatly improved by efficient EMIS. Information from EMIS can inform decisions about the deployment of human and financial resources in the education system.

Furthermore, information extracted from EMIS can inform human resource management and development. For instance, school head teachers can gauge the competencies of their teaching staff and subsequently enlist staff in training programmes to bridge competency gaps. Conversely, teachers can track their training history through EMIS, allowing them to extract information that they can use to justify their need for professional development. EMIS are also valuable in tracking the distribution and use of educational resources and the upkeep of school buildings and infrastructure.

Recent developments in EMIS enable institutions, district education officers, municipalities, and ministries to identify student and teacher absenteeism, which can help in defining remedial actions and even enable teachers to contact families and communities to understand why individual students are persistently absent. This might, for example, be due to onerous family responsibilities or economic hardship. Data on teacher absenteeism could help to design relevant policy responses: for example, in some countries, teachers have to travel some distance to collect their salaries from a bank during working hours. Understanding this as a cause of teacher absenteeism meant that other forms of payment, such as mobile banking, could be implemented.

B. Planning

EMIS are relied upon to develop realistic and cost-effective plans for the development of the education sector and monitor their implementation. The first concern of education planners should be to ensure that the State is meeting its obligations as the duty-bearer for fulfilling the right to education, even where there are a wide diversity of education providers operating in a country. This inevitably means that EMIS includes good-quality and up-to-date demographic data, including statistical projections that take estimated population inflows and outflows into account.

Education planners need access to detailed data nationwide, to be able to respond to changing learning demands, often within severely constrained education budgets. EMIS can also provide crucial information about school enrolments, participation and completion, disaggregated by age, gender, with or without disability, and other social categories as required by the plan and its performance indicators. These data are essential for planners to understand precisely which children, youth, and adults are at risk of being "left behind" or marginalized by the education system. Geographic location data can also be used so that planners can find out how educational opportunities and attainment vary across a country, and between urban and rural areas. This is especially important in the context of SDG Target 4.5 and its respective indicators, which demand parity indices and data disaggregation related to excluded, disadvantaged, or vulnerable groups.

Where EMIS contain local demographic statistics and information about participation in public and private schools, it becomes possible for planners to take effective measures towards equity and inclusion by addressing social disparities and meeting the needs of disadvantaged and vulnerable groups. Education planners also have a number of other data requirements that should accounted for in designing and developing EMIS. Indeed, EMIS usually provide the core information that serves as a basis for a country's Education Sector Plan.

EMIS provides education planners with essential information on demographic trends, as well as education inputs, processes, and outcomes. Timely, good-quality information can make a significant difference in decision-making at all levels of the education system. For institutions, it can inform decisions on what programmes to offer, which kinds of staff to hire, and what other kinds of resources are

needed to improve the delivery of learning. The analysis of data on social and educational disparities is necessary to justify the allocations of resources to disadvantaged communities, institutions or students to ensure equity and inclusion, and equality of opportunity at every level of an education system. As a result, ministries will be able to make smarter investments and allocate resources to where they are actually most needed, yielding better returns on investment whilst also potentially reducing costs. In fact, experience suggests that the cost implications of improving data quality through the installation of EMIS is, in the long run, likely to be less than the unnecessary costs caused by misguided expenditures due to lack of data (Porta & Arcia, 2011; Abdul-Hamid, 2014).

Countries that are eligible for financial support from the Global Partnership for Education, among others, are expected to conduct an education sector analysis to inform a well-costed education sector plan (ESP). This process is dependent on high-quality data of sufficient scope and geographical coverage, which can support projections and simulations for planning purposes. In doing so, planners should take account of all relevant policy frameworks and regional and international commitments. School mapping data, for example, are relevant for assessing the distribution of the school network and any other changes required in response to demographic trends, migration, and social needs.

C. Policy formulation

EMIS can make a difference by enabling an evidence-rich environment for policy dialogue and decision-making. Countries collect massive amounts of data every year, but if this data are not transformed into meaningful, relevant and understandable information coupled with analytical insights, it is unhelpful for decision-making (UNESCO, 2013). Edmunds and Morris (2000) talk about the paradox of organizations suffering from a "paucity of useful information" despite the "surfeit of information" that is available to them. Data are abundant; the issue lies in determining what kind of data are needed and how that data should be analysed and presented in ways that can actually inform decision-making. The identification of priority issues for in-depth analysis is possible with reference to existing education policies, plans, and performance indicators, as well as through close attention to current policy debates. Constant dialogue between EMIS staff and education stakeholders at various level is essential.

Even inside the Ministry of Education, the likely end users of EMIS information and analyses have different needs and diverse capacities. Policy-makers may need to take a big-picture perspective and may be less interested in the detail of specialized EMIS reports than education planners or researchers. This has implications for the way that evidence is presented to policy-makers. When policy-makers find EMIS responsive, informative, and dependable, their demand for EMIS is likely to increase. Policy-makers themselves need to learn what kinds of questions EMIS are able to answer. When policy-makers and decision-makers are convinced of the value of EMIS, it will be easier to build a culture of evidence-based policy-making.

Decentralization and trends towards more inclusive and participatory policy processes can also be supported by EMIS. The value of stakeholder consultations depends, to a large extent, on having engaged, informed, and empowered stakeholders. Even though opinions may differ, EMIS has a role to ensure that stakeholders can readily access relevant and quality information about education at various levels.

Education systems have been giving increasing attention to granular data, realizing their value in efforts to improve individual student learning outcomes. For instance, the UNESCO Institute for Statistics and the United Nations Children's Fund (UIS and UNICEF, 2016) emphasize the importance of EMIS in preventing school dropouts. Given the increasing attention to granular data, certain national governments in South and Central Asia (Bangladesh, Kyrgyzstan, Nepal, Sri Lanka and Tajikistan), in partnership with Save the Children and UNICEF, have implemented a Community-based EMIS (C-EMIS) (UIS & UNICEF, 2016). Through C-EMIS, the aforementioned countries directly correspond with families in their community to have a more holistic view of the various socio-economic and household-related factors that might hinder student achievement.

Given this, an evidence-rich environment is a necessary but insufficient condition to inform social dialogue and good decision-making in education: stakeholders also need to develop the capacities to access, use, and interpret EMIS information. Indeed, this is an essential aspect of accountability in education systems. Furthermore, social dialogue is best nurtured in contexts of openness, in which individuals are able to express opinions freely and without fear, and where differences are resolved in a spirit of mutual respect through conversation and consensus-building.

Since education reform is a slow process and its impact can take years, or even decades, to be felt, longitudinal data are likely to also be of particular interest to the policy community. The analysis of trends over time, whether for institutions or for learners, and the transitions taking place, can convince policy-makers of the benefits of EMIS.

In addition to longitudinal data and analyses becoming increasingly available to policy-makers, the fact that many countries have developed EMIS means that comparative information and data are now more widely available. This means that, where data based on similar indicators and methods are collected, comparative analyses can be done both of the current "snapshot" situation as well as comparative trends in education systems over time. Sharing experiences between countries that have pursued similar or different policy direction can help to ensure that policy processes do not take place in isolation, but can benefit from peer learning and an understanding of developments in the wider world. Where educational researchers engage with such data and take time to dialogue with policy-makers on their findings, EMIS can contribute to an international and comparative knowledge base on policies and trends in education. One of the invaluable roles of EMIS is the submission of statistical reports to the UIS, which makes comparative data available to research and policy communities for further analysis. Policy-makers can also benefit from the experiences of other countries that have set up and sustained EMIS, adapted to their respective country's own needs and policy agendas.

Since the 17 Goals of the 2030 Agenda for Sustainable Development are interlinked, public policies and programmes in otherwise different sectors of development should also build on each other. For example, in terms of climate action (SDG 13), education policy-makers could also be asking themselves how national curricula can be improved such that they increase awareness on environmental sustainability issues such as climate change, disaster risk reduction, and the promotion of sustainable lifestyles. Effective EMIS can help policy-makers in this regard by interfacing with other sectors' information systems and subsequently providing policy-makers with intersectoral data and analyses. These intersectoral analyses can then inform policy and programme development at the sub-national, national, regional, and international levels.

D. Monitoring and evaluation

All stakeholders, whether planners, administrators, policy-makers, community members, or others, benefit from knowing about progress over time in the field of education. EMIS can provide a way of monitoring education at various levels and of sharing evaluation feedback of various kinds. For instance, longitudinal learning assessment data could be used to measure the effect of a specific education policy on more abstract indicators like gender parity or quality of instruction.

In addition, if EMIS are linked to other government information systems, ministries of education will be able to perform cross-sectoral analyses (for instance, run education data against labour market data). The availability of historical data would allow ministries of education to assess the effectiveness of a policy or programme in facilitating a learner's positive participation in society, identify challenges, and extract lessons learned — all of which can inform future decision-making both in the short and long term

Moreover, historical and longitudinal data contained within EMIS also allow monitoring and evaluation for lifelong learning. EMIS can help schools and ministries of education measure post-completion outcomes of individual students – for example, if students have been able to successfully transition into the workplace or into higher levels of education. Historical data would also allow ministries of education to measure the effectiveness of ECCE programmes in terms of subsequent learning outcomes from basic education onwards.

At the same time, it should be recognized that policy-making and programme development in education are not purely scientific or rational processes. There are many considerations beyond education that influence education policies and programmes, as well as financial and political considerations. EMIS can undoubtedly make essential inputs to the needed transformations in the education sector, but even the best EMIS should be complemented with other knowledge, experience, and expertise.

E. Components of an effective EMIS

Effective EMIS should be able to respond in a timely but flexible way to various demands for data on education and development, whether coming from national authorities, other national stakeholders, or development partners. Importantly, EMIS should facilitate education and lifelong learning system development able to keep pace with and support innovation and reforms in the field of education.

Effective EMIS are therefore learning systems in their own right, able to not only respond to present demands for data but also to evolve according to emerging and future demands through constant dialogue with education planners and policy-makers. To be effective, EMIS should have a research function that, through critical inquiry, including research visits to education stakeholders at the school level, are able to support their evolution in light of changing demands.

EMIS should also be designed according to country contexts and needs; no one system configuration will work universally across all countries. However, while EMIS should be designed and adapted to country contexts and needs, there are nevertheless some characteristics that are likely to be present in all effective EMIS. According to the World Bank's Systems Approach for Better Education Results-EMIS (SABER-EMIS) Framework, these include:

1. **An information cycle.** Effective EMIS track inputs and analyse data such that education actors can assess how effective existing policies and institutions are. This creates a feedback loop that informs policy actions and decisions (UIS, 2017).
2. **Data coverage.** Effective EMIS maintain both raw data (e.g., payroll, staffing complement) and aggregate information (e.g., enrolment rate, completion rate, dropout rate). Aggregate information allows education actors to have a greater understanding of the education system and is therefore crucial to effecting policy and programme improvements.
3. **Data use and effectiveness.** Data produced by the EMIS should be readily understandable, usable, and actionable. According to UIS (2017), EMIS data serve not only statisticians but also other actors who have a stake in education-related policy and programmes. This enables the use of data for daily operations, target-setting, policy-making, and results monitoring, among others. As such, data can be used to determine priority improvements to the education system.
4. **Multifaceted system.** Effective EMIS do not exist in a vacuum (Abdul-Hamid, 2014; World Bank, 2015). For EMIS implementation to succeed, technology must be supported by institutional systems and structures that facilitate the collection, processing, and dissemination of data within organizations.

However, while SABER-EMIS provides a very good guiding framework for the development and reinforcement of EMIS, it can still be enhanced to better fit the enlarged demands of SDG 4-Education 2030. One major adjustment that can be made to align better with SDG 4 is to expand the SABER-EMIS framework beyond formal educational institutions.

Currently, SABER-EMIS "highlights the policies and institutions that matter most to promote learning for all children and youth" and seeks to provide "an accessible, detailed, objective snapshot of how well the policies of [a] country's education system are oriented towards ensuring that all children and youth learn" (World Bank, 2016).

Given SDG 4's emphasis on lifelong learning, it is no longer sufficient to focus solely on the education of children and youth; there is a need to consider adult skills and adult learning, as well as non-formal education platforms.

Data quality is another important indicator of how strong an EMIS is. UIS (2018b), for instance, cites the following hindrances to the efficient collection and effective use of education data:

- **Schools only produce data to report upwards** – that is, to national governments and international organizations. Schools do not always find data relevant to their contexts, or even if the data were objectively relevant and useful, they have little incentive to actually use the data.
- Many countries **lack systems to compare and benchmark** on each other's practices, neither in terms of processes nor outcomes.
- The **same solutions have been used for different data issues**. Data systems vary from one country to another, but the approaches to improving those systems have been mostly uniform (e.g. provision of training, funding increase).
- Education systems generally **do not report the data that matter most**; the evidence on which inputs have the most significant effect on outcomes has been, for the most part, ignored. For instance, many education systems continue to place an emphasis on enrolment, even when evidence shows that attendance and absenteeism have a greater effect on education outcomes.
- **Data on out-of-school children are generally excluded** from reports furnished by ministries of education. Reporting on out-of-school youth is usually left to NGOs and development partners, which do not always communicate with each other (although the situation is improving).
- **Household survey data are often still misused or distrusted** by education planners, who are often unaware of how useful household data can be, if properly collected and analysed.
- **Innovation in education is often ignored**, despite the increasing need to incorporate new approaches (such as the use of technology for pedagogy) into traditional ones.

Addressing these data-related hindrances is key to realizing the potential of EMIS in the pursuit of SDG 4 targets. However, EMIS in several countries either continue to produce data plagued by these incongruences, or fail to produce data that are critical to improving and measuring the effectiveness of their operations, policies,

and programmes. Therefore, it is important to identify what constitutes quality data.

The Education Data Quality Assessment Framework (Ed-DQAF) is a rubric for assessing a country's quality of education data, taking processes for data collection, reporting, and analysis, institutional environments, and resulting statistical products all into account. As such, Ed-DQAF can be used to assess how reliable a country's education data are and, subsequently, how useful those data would be for policy-making. Ed-DQAF lays out the following dimensions of data quality:

1. **Integrity.** Data should be collected, compiled, and disseminated in an impartial manner – that is, without undue influence from external or internal parties. This dimension is grounded on professionalism, transparency, and adherence to ethical standards.

2. **Methodological soundness.** Statistics should be produced in line with "internationally accepted standards, guidelines, and good practices." Naturally, the appropriate methodology varies across data sets; the analyst should employ the statistical tools that correspond with the types of data that need to be analysed.

3. **Accuracy and reliability.** Statistical outputs should reflect the realities of the country. As such, there should be mechanisms to ensure accurate reporting from data sources and to validate data analyses.

4. **Serviceability.** Statistics should be relevant to the subject being examined, produced in a timely and regular fashion, consistent with other major data sets, and subject to regular updating as needed. They should be useful to the stakeholders that produce them.

5. **Accessibility.** Data and metadata should be readily available and should be presented in a clear and understandable manner. Parties that wish to perform analyses using the data set should have access to a support service that would help them make sense of the data.

If all these dimensions are present, policy-makers can be sure that they are working with reliable data and can subsequently come up with more relevant policy recommendations. The dimensions of data quality laid out in Ed-DQAF are dependent on various factors, such as the processes, competencies, and standards existing within an organization. In effect, good data quality is the product of good institutional practices.

Section III

Strengthening EMIS capacities to support SDG 4

Most countries have some form of EMIS in place. As such, the pressing issue is how to ensure that EMIS functions as efficiently as possible. This is a capacity issue that can be explored from different angles: technical capacity (clearly defined needs, data quality, and robust technological infrastructure), human resources (beyond the technical staff, therefore also including the capacities of end users), and policies, plans, and institutional arrangements (including EMIS leadership and management).

A. Technical capacity

An EMIS is based on three basic technical assumptions: a) that there is a clear definition of the needs to be addressed through EMIS; b) that it can work on the basis of quality and reliable and constantly updated data; and c) that there is a sufficiently robust technological infrastructure (notably a software platform but also the channels for collecting and processing data).

A realistic needs analysis

Identifying the insights needed by the ministry to generate effective policies and programmes, as well as the information necessary to produce those insights, is a prerequisite to the success of any kind of information system. Moreover, since contexts vary from one country to another, it is imperative to have a full understanding of the country's current capacities before undertaking EMIS development or reinforcement. It must be stressed that there is no such thing as a one-size-fits-all EMIS solution; the best EMIS solution is one that is tailored to a country's needs and contexts (technological, human, and institutional). For these reasons, needs analysis is a critical phase in EMIS-related initiatives.

EMIS can only be effective if they are aligned with the information needs of an education system (Carrizo, Sauvageot, & Bella, 2003). It is therefore also essential to have a thorough understanding of how the education system works to arrive at a nuanced understanding of that system's information needs (UNESCO-IIEP, 2012). As such, before proceeding with EMIS reinforcement efforts, a needs analysis must be performed. UNESCO (2012) proposes the following questions as critical to understanding an education system's information needs:

a What types of information are needed to ensure effective management at different administrative levels of the education system?
b What are the main challenges faced by policy-makers and other education actors regarding how data are structured and organized?
c What are the resources, both financial and human, currently available to the education ministry for data management?
d What methods and approaches does the education system currently use to manage information?
e What sources are available for specialists that want to acquire the required competencies for managing information effectively?

Answering these questions is an important first step to ensuring the utility of EMIS to policy-makers, administrators, and other education stakeholders. Naturally, to answer these questions, policy-makers, administrators, and other education stakeholders themselves must be consulted, since they will be the primary users of EMIS. Furthermore, an education system's information needs must be regularly reassessed to check if the EMIS currently in place still responds to them. Information needs are not static; they evolve. As such, an effective EMIS must also evolve in response to those changing needs.

If done properly, the needs analysis should reveal not only the appropriate technical configuration for EMIS but also the types of data and corresponding reports that the system should be able to produce. This analysis should also assess pertinent human resource capacities and competencies, as well as describe how information currently flows within the education system. Once equipped with a better understanding of the current state of the education system, ministries of education can then proceed to developing and configuring the EMIS software. The implementation of StatEduc in Burkina Faso is testament to the importance of a comprehensive and realistic needs analysis to the success of EMIS reinforcement initiatives (see Box 3).

Quality, reliable, and recurrently updated data

Having credible, reliable, and timely data is the first prerequisite to effective EMIS. In line with this, the World Bank and the UIS (2004) jointly developed Ed-DQAF. Of course, a management information system is only as good as the information it contains. According to the Organization for Economic Co-operation and Development (OECD, 2015), the value of a data set can be assessed based on (a) data portability and interoperability, (b) data linkage and integration, and (c) data quality, among others. In simpler terms, data become more valuable if they can be used and applied in various contexts, and if they are able to "speak" with

other data sets. More importantly, though, data should be credible, timely, and interpretable (that is, able to be subjected to analysis).

Box 3. Case Study: Burkina Faso

In 1996, the Government of Burkina Faso recognized basic education as one of its priority development areas, resulting in the creation of a comprehensive plan for the education sector called the *Plan Décennal de Développement de l'Éducation de Base (PDDEB)*. This plan was formally adopted in 1999, and aimed primarily to expand access to education, improve quality of education, and address the country's high illiteracy rate.

In 2000, the Ministry of Basic Education and Literacy (*Ministère de l'Enseignement de Base et de l'Alphabétisation*, MEBA) recognized that, in order to achieve the objectives defined in the PDDEB, it needed a way to concretely measure education outcomes. As such, MEBA assigned its Directorate for Research and Planning (Direction des Études et de la Planification, DEP) to develop a software that would facilitate the collection, analysis, production, and dissemination of statistics for basic education.

MEBA therefore sought the assistance of UNESCO to conduct a thorough diagnostic analysis of their current information management system. UNESCO's diagnostic analysis considered infrastructure, institutional capacity, human resource capacity, and existing data processes. This diagnostic analysis revealed four main pain points in the current system: (1) weak integration in institutions; (2) weak infrastructure; (3) inadequate human resource capacity; and (4) low data quality. Given these identified pain points, UNESCO therefore adjusted its approach to address these issues.

For instance, since UNESCO saw that Internet connectivity was not readily available across the entire country, MEBA configured StatEduc, its EMIS software, such that it incorporates both online and offline methods of data collection. This cohabitation of technologies allowed MEBA to capture data from all areas of Burkina Faso – even from areas with limited or no Internet connectivity.

In addition, since data accuracy was a key issue, MEBA designed a data validation mechanism in StatEduc: the software automatically detects and flags potentially erroneous data. This acts as a significant deterrent to data falsification.

These features would not have been configured in StatEduc, had a comprehensive needs analysis not been performed beforehand. This needs analysis also led MEBA and UNESCO to take a capacity-building approach in terms of human resources, ensuring that qualified statisticians are hired by MEBA and that existing staff are trained not only in the use of StatEduc, but also in their general data analysis competencies. Other best practice elements, as well as the challenges faced by Burkina Faso throughout its implementation of StatEduc are discussed in further detail in the full case study document in Appendix B.

Comparative data should also be present in EMIS. This allows local policy-makers to not only compare their country's educational outcomes at an international scale, but it also allows them to benchmark against international best practices (World Bank, 2016).

However, while household surveys are potentially very powerful sources of data, their collection and interpretation require methodological rigour. For instance, UIS (2018) mentions how household surveys are often done improperly by education planners: imprecise survey items leading to ambiguous responses, indicators that do not conform to international standards, and incorrect sample weighting, among others, are common issues that render household data unusable.

Ministries of education should also strive to expand EMIS coverage beyond the public education system. An EMIS will be able to provide a more complete view of the education system if it includes data from educational institutions that are, in some countries, not within the purview of the ministry of education, such as private schools, TVET providers, special education schools, and non-formal education platforms.

Similar gains have been observed in information systems implemented in other sectors of government, such as the health sector. Braa, Monteiro, and Sahay (2004), for example, characterize successful health information systems (HIS) as building "networks of action": Local HIS interface with the national HIS, as well as with other HIS within and across countries. This allows public health professionals to monitor health outcomes at the local, national, and international scale, which means that they can not only synchronize their policies and initiatives but also adapt them to local needs and contexts. These networks of action are equally relevant to the education sector, especially in light of the general movement towards decentralization.

A robust technological infrastructure

Building infrastructural capacity is also key to the success of EMIS. Many EMIS projects fail, for instance, when external consultants attempt to install sophisticated software that cannot be supported by existing infrastructure on the ground (Lovely, 2011). For example, installing a web-based software in an area with unreliable Internet connection is unsustainable. These infrastructure issues can be addressed by: (a) assessing the current infrastructural capacity of the ministry and ensure that the software to be installed can be supported by the existing infrastructure; and (b) in parallel, investing in infrastructure that would allow the ministry to eventually install more powerful EMIS software.

Combining manual and automated methods is another possible approach: areas that have limited or no Internet connectivity may collect and enter data manually and then transmit that data to Internet-capable centers for uploading.

However, while infrastructure capacity is an important determinant of the technical effectiveness of EMIS, the ability of these systems to integrate with other information systems remains the principal determinant. Effective EMIS should not only be able to use data *from* other information systems, but should also be able to produce data that are useful *for* other information systems. Successful information systems connect public sector organizations both vertically (for example, field offices to the central office of the same ministry) and horizontally (that is, across different ministries; see Ebrahim & Irani, 2005 and Chen, Chen, Huang, & Ching, 2006).

This is of particular interest to developing countries, where government ministries have traditionally maintained separate databases that do not communicate with systems from other government ministries — sometimes not even with systems used by other offices in the same ministry (Ebrahim & Irani, 2005). This is especially important in the context of SDG 4, as SDG 4 targets require data on lifelong learning, often available in different ministries. Furthermore, since the 2030 Agenda for Sustainable Development stresses the interconnectedness of the SDGs, the integration of various government data systems becomes a necessity for the development, implementation, and monitoring of public policies.

To ensure the smooth integration of information systems, UNESCO (2012) recommends the creation of a computerization master plan. A computerization master plan should establish a timeline for introducing the technology and lay out all interconnections between different subsystems within the larger information system (UNESCO, 2012).

UNESCO, with its mandate to provide policy development and implementation advice in the field of education, as well as to develop the institutional capacities of its Member States, possesses the expertise and competence to offer technical guidance to countries seeking to augment their technical infrastructure and streamline their data-related mechanisms and methodologies. Moreover, UNESCO's leadership role in the SDG4SDG 4-Education 2030 agenda allows the organization to facilitate cooperation between and within national governments, as well as mobilize partnerships with private and non-governmental actors, for the purpose of equipping ministries of education with the needed competencies and technologies that would help them attain the targets set by SDG 4. This extensive network also enables UNESCO to work with both local and international experts to define criteria for selecting software solutions and implementation partners that are suited to the needs of individual Member States.

B. Human resources

Considering the definition of EMIS as "the ensemble of operational processes, increasingly supported by digital technology, that enable the collection, aggregation, analysis, and use of data and information in education planning, monitoring and evaluation, policy analysis, and decision-making," it is clear that many different kinds of human capacities have to be developed and mobilized. Users and administrators not only need to be able to operate the system but also be able to convert data into usable statistics that prompt action or inform discussions (World Bank, 2016): whatever meaning that can be drawn from data is determined by the analytical competence of the analyst (OECD, 2015).

Therefore, to ensure the success of EMIS development and reinforcement, the education system staff must have the competencies needed to not only run the EMIS but also derive insights from the data stored within it and make those insights meaningful for stakeholders. This has implications on human resource management, particularly on training and organizational structures. For instance, if EMIS software is procured from an external provider, the procuring ministry should insist on a capacity development approach (World Bank, 2016). Otherwise, the education ministry, given its lack of in-house technical competency, runs the risk of overdependence on external consultants, resulting in weak ownership of the system and, consequently, low system use (Adam, 2011; Abdul-Hamid, et al., 2017). This is particularly important in developing countries where sustainability failure is quite common for information system installations; that is, while an information system may appear successful in the beginning, it is eventually abandoned due to the government's lack of capacity to operate and maintain it (Heeks, 2002).

Training users and system administrators on the full functionality of the EMIS contributes to its institutionalization, thus making the system more sustainable (Carrizo, et al., 2003). As such, the ministry should allocate a sufficient budget for the training and capacity-building of EMIS staff. These training initiatives should regularly update the knowledge of users and system administrators based on upgrades in the EMIS or broader changes in the education system (Abdul-Hamid, 2014).

Providing training to administrators is not sufficient on its own, however. Trained EMIS staff can only succeed in their functions if the organizational structure they operate in supports the fulfilment of their roles. In light of increasing decentralization in the education sector, capacity should be developed not only at the central administrative level but also at geographically decentralized offices (UNESCO, 2012). Otherwise, inadequate capacity on the ground could paralyse the flow of information within the education system. The experience of the Maldives' Ministry of Education in rolling out their EMIS, described in Box 4 below, illustrates a good approach to developing human capacity all the way from the central unit down to the school level.

Box 4. Case Study: the Maldives

The Maldives, in partnership with the UIS and UNICEF, sought to strengthen their EMIS in December 2015. In search of a system that was fully customizable according to country needs, and where the Ministry of Education would have full ownership of the software and the data it contained, the Maldives opted for OpenEMIS. OpenEMIS therefore served as the base software for the Maldives Education Management Information System (MEMIS).

Recognizing that a move from manual processes to a digital system for data collection, analysis, and reporting would require new competencies, the Maldives' Ministry of Education thus took a capacity-building approach that would equip its staff, from the central office all the way down to individual schools, with the knowledge and skills they would need to navigate MEMIS. However, given the archipelagic geography of the Maldives, it would take a huge amount of time if central office MEMIS administrators were to travel to each school to administer training. To address this, the Ministry used the training-of-trainers method.

The Ministry of Education began implementation of MEMIS with a pilot run for 20 schools, chosen in terms of their respective area (urban or rural) and their respective academic level (primary school or secondary school). Once the pilot schools were identified, the Ministry then brought the respective principals and IT staff of each pilot school to Malé for a week-long orientation and hands-on training on the system functionalities of MEMIS. These principals and IT staff would eventually become the designated local MEMIS Administrators for their respective schools. Their training, however, did not focus solely on ensuring that they knew how to navigate the functionalities of MEMIS; they were also trained in such a way that they themselves would be able to train their colleagues on how to use MEMIS. This made for faster cascading of the competencies needed to roll out MEMIS. In addition, this method provided the Ministry with MEMIS advocates on the ground, who would see to it that school staff not only knew how to use the system, but were also actually using it. Seeing how this method succeeded during the pilot run, the Ministry used the same method when they rolled out MEMIS to the rest of the education system.

In addition, to ensure complete mastery of each MEMIS functionality, the Ministry staggered the release of MEMIS modules, training school staff module per module. While this method is certainly more time-consuming than a one-off training on all MEMIS functionalities, this allowed school staff to have a good grasp of what each module was for and how they could use each module in their work. At the time of writing, this module-by-module training is still ongoing. This is particularly useful, given the iterative approach that the Ministry is taking in developing MEMIS. This enables the Ministry to gather constant feedback on the functioning of MEMIS, identify pain points, and make the necessary improvements based on feedback on the system.

This capacity-building approach, along with other good practice elements in the Maldives' Ministry of Education's implementation of MEMIS, is detailed in Appendix C.

Capacity development must be at the centre of people-focused initiatives in EMIS reinforcement. Failure to equip users and administrators with the competencies they need to navigate EMIS is tantamount to the failure of EMIS itself. It is important to note as well that capacity development is not a one-time initiative. Capacity development must be constant; training, retraining, coaching, and mentoring should occur regularly and consistently to ensure that users and administrators keep up with changes in EMIS, as well as in the broader education system. Since education systems are constantly evolving, EMIS, as well as the competencies of users and administrators, should constantly evolve with it, too.

Teachers and head teachers also play an important role in this process as they are the primary sources of school-level data. By diligently transmitting data to the national government, school staff should gain access to comparative data that allow them to assess their own school's performance vis-à-vis other schools. This reinforces buy-in at the school level. Access to information that is directly relevant to their schools serves as an incentive for school staff to participate in data collection.

Buy-in is very important; it is not enough to coerce school participation through top management-driven memoranda. When lower-level education administrators participate in data collection only to comply with directives from top management, they tend to be less motivated, therefore increasing the likelihood of inputting erroneous data (UNESCO, 2012). This strategy of providing incentives for participating in data collection is an approach that ministries of education can also take when attempting to involve other educational institutions in EMIS-related initiatives.

As mentioned earlier, the inclusion of data from private schools, TVET providers, special education schools, and non-formal education platforms, among others, provides decision-makers with a more holistic view of the education system. However, convincing these institutions to provide data can be challenging; as such, they should clearly see how they can benefit from doing so.

Of course, democratizing access to educational data means that stakeholders outside the education system should also have access to educational information. As such, the capacity of these stakeholders to use, interpret, and report data accurately is also of concern to ministries of education.

The need to clearly communicate about responsible interpretation and reporting of educational data also extends to stakeholders from other government agencies. With EMIS data now also envisioned to provide input into the information systems of other government agencies, it is important that stakeholders in other sectors (such as health, employment, or environment, for example) have the capacity to properly use educational data for generating intersectoral analyses and developing intersectoral policies and programmes.

In sum, the effective production and reporting of educational data require capacity-building for different stakeholders, both internal and external to the education system. Of course, different stakeholders would have different capacity needs. Ministries of education must therefore understand and address these varying needs by directly working with their stakeholders.

UNESCO, in keeping with its mandate to assist Member States in augmenting human resource capacities in their respective ministries of education, supports training and capacity-building initiatives related to EMIS. The Organization has extensive experience in helping countries identify their human resource needs with respect to the implementation of both national and international education policy initiatives, and in assisting countries in bridging their human resource gaps, focusing on initiatives that are suited to the country's current capacities. UNESCO is able to provide customized training and coaching to Member States through its specialized institutes, such as the International Institute for Educational Planning, the UNESCO Institute for Statistics, and the UNESCO Institute for Lifelong Learning.

UNESCO does not develop capacities and competencies solely through training and coaching initiatives: the Organization sees capacity-building as a sustained endeavour rather than a one-off concern that can be addressed by single training sessions. As such, UNESCO maintains a close partnership with national governments through its network of field offices.

Peer learning is another equally important method of building competencies — a process that UNESCO facilitates through conferences and other avenues for knowledge-sharing among different Member States. UNESCO also strengthens these networks of practice, allowing policy-makers to learn from each other, through the constant production and dissemination of knowledge materials (such as working papers, guides, and publications) documenting good practices and lessons learned.

UNESCO is therefore a critical, long-term partner of Member States in developing the human resource capacities and competencies needed to support the re-orientation of EMIS towards SDG 4.

C. Policies, plans, and institutional arrangements

Organizational structure is an important factor in ensuring timely data production; in many countries, for instance, delays in publishing statistical yearbooks are at least partly attributable to weak coordination and unclear delegation of roles (UNESCO, 2012).

Data must also be collected in a credible manner: whoever is responsible for data collection should exercise technical independence, be free of outside interference, be transparent, and follow ethical standards for research (World Bank, 2016). To ensure the veracity of data inputted into the EMIS, there should thus be a data control process that checks if data are updated, complete, consistent, and relevant (UNESCO-IIEP, 2012; UIS & UNICEF, 2016). Systematizing a formal data quality assurance procedure builds institutional capacity and reinforces institutional memory (UNESCO, 2012), in effect strengthening the ministry's data use culture.

Openness of data is another telling indicator of strong data use culture in a MoE. Such MoEs have moved from a paradigm of data control to data sharing; education data are easily accessible and readily available to the public (Hua, 2011). The publication of data reinforces transparency, which in turn creates a greater sense of accountability in the ministry. On the contrary, ministries that erect barriers to data access tend to stifle collaboration, innovation, and service improvement (OECD, 2015).

Resource allocations for EMIS-related activities are also indicative of data use culture (UIS, 2017). This means that the ministry should provide human, material, and financial resources to support the effective implementation of EMIS. Specifically, the ministry should provide a budget not only to hire staff that will be responsible for the administration of the EMIS, but also to continually train EMIS staff and update their knowledge vis-à-vis changes in the EMIS, and even in the broader education system. Moreover, there should also be sufficient budget to cover the technical maintenance and updating of the EMIS; neglecting to programme funding for technical aspects is a common hindrance to sustaining EMIS (Lovely, 2011). Especially in countries that are undergoing education reforms, there should be a budget for updating EMIS functionalities to accommodate and synchronize with changes in the broader education system. Otherwise, failing to provide resources for EMIS maintenance can also result in sustainability failure (Heeks, 2002).

To ensure continuity, there should be an operational unit within the ministry that is specifically dedicated to administering and maintaining the system (Hua & Herstein, 2003; Lovely, 2011). Furthermore, core EMIS staff should have clearly defined tasks and responsibilities (Carrizo, et al., 2003). Core EMIS staff should have a thorough understanding of the country's education system and be knowledgeable about current and prospective reforms (Lovely, 2011).

However, in installing this kind of organizational structure, the ministry must be wary about silos; the EMIS workflow should be well-defined, clearly identifying all interdependencies and ensuring that interdependent units coordinate as they should. Coordination should be smooth both vertically and horizontally across the organization. In terms of the vertical structure, data should easily flow top-down and bottom-up; that is, central office ministry staff should be able to readily obtain data from decentralized units, in the same way that decentralized units should have access to national-level data that is generated at the central office. In terms of the horizontal structure, the different departments involved in education should have a mechanism for data-sharing, allowing them to align analysis and reporting. Different departments should work together as part of one organic unit, rather than as separate, isolated units.

To avoid such silos, ministries usually set up a coordinating group for EMIS – an interdepartmental group that harmonizes the information needs of different stakeholders (Carrizo, et al., 2003; Hua & Herstein, 2003). This coordinating group can also help minimize data redundancies by assigning specific data sets to specific units. This group can even include representatives from other ministries whose mandates are also related to the provision of education services. For instance, if the responsibility for TVET is outside the MoE, the relevant authorities can and should be included in the interdepartmental group. This way, the government has a more comprehensive view of the education sector.

These coordination structures and data processes must be anchored on an overarching legal and policy framework that describes how EMIS function and how they influence the ministry's strategy and operations (World Bank, 2016). This framework should detail: (a) which office(s) are designated to administer EMIS; (b) the tasks and responsibilities of EMIS administrators; (c) the end-to-end process from data collection to dissemination of findings; (d) budgetary guidelines for EMIS operation and maintenance; and (e) data use guidelines, among others.

In turn, this EMIS legal framework should be aligned with the broader national policy on the management of public data, as laid out by the country's respective ministry of information or the equivalent ministry. Aligning the EMIS legal framework with the larger national policy should allow for better synchronization and coordination across different government agencies, which would then facilitate intersectoral analyses and intersectoral planning. Myanmar's Five-Year EMIS Strategic Plan, (see Box 5) is a promising policy framework in that it seeks to harmonize education data from different sources in a single, easily accessible portal and takes a holistic approach in developing the capacities needed.

Box 5. Case Study: Myanmar

The Government of Myanmar considers EMIS reinforcement as a critical reform requirement for its education sector. Given this, its Ministry of Education has prioritized EMIS-related initiatives in its Education for All Action Plan. Myanmar intends to use EMIS data to improve: (a) access and quality of education services; (b) efficiency of resource management in educational institutions; and (c) Information and communication technology (ICT), planning, and professional competencies of education administrators.

To ensure the attainment of these objectives, the Ministry has developed a Five-year EMIS Strategic Plan, and has solicited the technical support of UNESCO through a partnership with UNESCO's Capacity Development for Education Programme (CapED). CapED-UNESCO's implementation strategy emphasizes the following elements:

- Building competencies of MoE staff
- Improving access to education data through a unified Education Portal
- Improving data quality
- Enforcing data-driven school planning

Myanmar's MoE formed a team, composed of twelve members, especially dedicated to the EMIS reinforcement project: the EMIS Implementation Unit (EIU).

The unified EMIS software system will house all education data from different sectors within the education system, containing data as granular as individual school data, as well as data from TVET institutions and non-formal education platforms. As a first step to installing this software, CapED-UNESCO and the EIU will map out reporting and data requirements. Reporting formats shall be standardized, and training materials on how those reports are to be interpreted shall be developed. This Education Portal will then be piloted with decentralized units to ensure that the system functions as intended. Once the pilot is successful, the Education Portal will then be rolled out to the entire Ministry, accompanied by technical training on operation, backup, maintenance, and restoration of the software.

Such capacity-building initiatives shall be implemented all the way to the school level to ensure that school administrators are also able to use EMIS data to effect direct, more immediate improvements in their respective schools. As such, school administrators will be able to generate and interpret reports from the Education Portal as well, creating an incentive to participate in EMIS data collection. To reinforce institutional memory, CapED-UNESCO will also incorporate data analysis and evidence-based decision-making into the Programme Development Module of the National Education Management and Training Centre.

Myanmar's EMIS Strategic Plan can be considered a promising framework since it is holistic and systemic. CapED-UNESCO and Myanmar's Ministry of Education shall be addressing not only the technological aspects of EMIS, but also the material, financial, human, and institutional aspects of the system.

In the context of SDG 4, multiple ministries are often involved in implementing and monitoring education policies and programmes. Having said that, an enabling legal and policy framework to ensure coordination and establish clear EMIS leadership (often by MoEs) becomes even more crucial to the success of EMIS. This is vital because it is this leadership that will facilitate the development of the education system's vision of EMIS and steer the education system towards achieving that vision.

Educational leaders push for a paradigm shift — that is, from viewing EMIS not only as an administrative tool but also as a strategic instrument for planning, policy-making, and programme implementation and evaluation. A shared vision for EMIS is hence a critical driver of successful EMIS development and reinforcement.

UNESCO is well placed to assist Member States in defining their shared vision for EMIS, given its function of setting norms and standards in education policy. In light of the targets set by the Sustainable Development Agenda and how EMIS is progressively becoming an area of key interest in the pursuit of SDG 4, there is an emerging need to set norms and standards for its development and reinforcement. UNESCO can serve as the platform by which such norms can be discussed, and subsequently serve as a key partner in helping countries enforce those standards.

Section IV

The future of EMIS

Effective EMIS are crucial tools in national strategies, as well as in the SDG outcomes. Whereas the Education for All (EFA) movement and the education-related Millennium Development Goals (MDGs) provided a strong focus on access and participation in basic education, SDG 4-Education 2030 has a more ambitious scope including all levels and types of education as well as increased focus on equity and inclusion, and new attention to the quality and relevance of learning. There is also for the first time a strong intersectoral dimension to SDG 4 that stresses the development contribution of education and lifelong learning to progress in other areas of development across the 17 SDGs. However, where EMIS have been developed, most countries are yet to make the corresponding adjustments in their system that could help provide the necessary information and analysis to inform national policies towards the eventual achievement of the Sustainable Development Goals and targets.

A. Community-based EMIS

MoEs with fully functional EMIS that are looking to transform their current system could consider adopting Community-based EMIS (C-EMIS), as studied by UNICEF & UIS (2016). In C-EMIS, schools liaise directly with children and their families to identify issues linked to scholastic difficulty. By directly communicating with their stakeholders (through home visits, for example), schools can better understand the needs of their community and hence adapt learner services to more effectively address issues such as dropout and non-enrolment (Williams, 2004). This not only allows schools to collect data from young people but it also allows them to verify data reported in EMIS (Williams, 2004; UIS & UNICEF, 2016). Most importantly though, engaging the community in the management of the education system creates a sense of local ownership and accountability for educational outcomes (UIS & UNICEF, 2016).

The success of C-EMIS initiatives manifest as increased school participation rates (Williams, 2004). Williams (2004) describes this community-based approach as more inclusive, since it allows schools to connect not only with enrolled children but also with those who are out-of-school. This is an important characteristic because out-of-school youth remain largely invisible in data furnished by ministries of education (UIS, 2018b). C-EMIS carry a potential to help ministries of education understand the situation for both formal and non-formal education and better 'see' young people who are not attending schools.

C-EMIS type systems typically provide a broader range of data than traditional EMIS, thereby, enabling schools to better respond to the needs of local communities. The success of these systems depend on credible, well-established processes for data collection, analysis, and reporting. Because Education 2030 requires a more comprehensive, whole-of-system approach and closer integration of data about different subsectors of education, countries may wish to think beyond the traditional categories of educational data. Rather than organizing data mainly on type and level of education, priority areas for data collection and analysis could correspond to knowledge gaps on such cross-cutting issues as learning pathways, ICTs in education, and the promotion of equity and inclusion. Such data on transversal themes are important for administration, planning, policy formulation, and monitoring and evaluation.

Numerous countries have started linking learners' educational records with data from other government agencies, covering human services addressing everything from mental health, family welfare, and rehabilitation for criminal offenders. These integrated systems can yield powerful insights that promote a more holistic understanding of a particular learner's experiences. They also show how education influences — and is influenced by — other domains and, in this way, reflect the "interdependency" principle of the Sustainable Development Agenda. The result is data that can, for example, show relationships between education and other development priorities such as poverty, health, gender equality, and climate change mitigation.

Integrated data systems are already being used at national and local levels and have helped reveal correlations and causations previously unknown to researchers. They point to strategies to improve educational services and other social services that influence educational outcomes.

Pittsburgh, a large city in the United States, is a case in point. Starting in 2009, the Pittsburgh public school district agreed to share information with a data warehouse maintained by the city's department of human services, which covers a wide array of social services peripheral to education. The school system pulled information from its information management system about individual students including their names, home addresses, grade point averages, standardized test scores, attendance records, and involvement in special education programming. By comparing educational data with data from other agencies, researchers were able to identify unknown connections

between, for example, learners being bullied in school and the onset of health problems and clear linkages between family disruptions such as divorce or domestic disputes and school attendance and performance. The information helped school staff to look for underlying problems when they saw an increase in absenteeism or a sudden dip in test scores. The data also allowed researchers to analyse suspension data in order to pinpoint the homes and neighborhoods of high-school students who frequently got in trouble. This information was used to allocate security and prevention resources and to initiate collaborations with law enforcement bodies (Herold, 2015). The integrated system used in Pittsburgh was funded through a grant from the Actionable Intelligence for Social Policy, an initiative that focuses on the development, use, and innovation of integrated data systems (IDS) for policy analysis and programme reform. Similar data-sharing initiatives and institutes have emerged worldwide to show connections between education data gathered through EMIS and data captured by other government departments.

Efforts to integrate previously walled-off data to reveal insights about the delivery of social and other services are primed to accelerate. Educators have long known that learning intersects in complex ways with domains outside education. Some of this is obvious: students who are hungry have trouble learning; but some of it is less obvious and can only be illuminated by crossing educational data with data from different sectors. For example, the widely corroborated finding that extracurricular activities seem to have a direct and positive link to student performance required looking at data sets that went beyond schooling. Robust and nuanced EMIS data provide a foundation to better understand the interconnections between education and other areas of life. These understandings hold a potential to accelerate progress not only towards SDG 4 but the full range of SDGs. Today, questions about how education connects to health, welfare, well-being, and peace are muddy at best, but in the future — with vastly expanded data sets that are interoperable — researchers may be better able to answer them and trade a myopic view of education for more accurate and more expansive outlooks that encompass multiple sectors.

B. Longitudinal data

Related to the trend to integrate disparate data sets, the world has witnessed a growth in longitudinal data systems. This practice is particularly advanced in the United States since a branch of the US Department of Education began awarding Statewide Longitudinal Data Systems Grants in 2005. The grants seek to propel the successful design, development, implementation, and expansion of early learning through the workforce longitudinal data systems in order to enhance the ability of states to efficiently and accurately manage, analyse, and use education data, including individual student records. The ultimate goal is to tailor and better leverage EMIS to help states, districts, schools, educators, and other stakeholders make data-informed decisions to improve student learning and outcomes, as well as to facilitate research to increase student achievement and close achievement gaps. The grants have helped states connect information from primary education, higher education, and workforce institutions in order to better align educational practices with workforce needs, produce a higher-quality workforce, retain higher education graduates, and employ graduates in meaningful and productive jobs. The resulting data infrastructure is an early example of what EMIS for lifelong learning might look like: a system that can follow learners from their earliest educational experiences through to full-time work and perhaps beyond.

While such longitudinal systems used to be constrained by data availability, this former 'bottleneck' is increasingly becoming an ocean of information. The amount of data being collected about learners is growing significantly, especially as student work moves into digital mediums where everything from examination scores are recorded, to individual keystrokes, response times, changed answers, pages read, and information about a myriad of other inputs. In many countries, the challenge today is coming to a clear understanding about what data are worth tracking and tabulating, and how they will complement other information in a longitudinal data set.

Expectations for longitudinal studies of education run high, in part because of the revelatory findings derived from longitudinal research on health and general well-being, such as the nearly 80-year-old Grant Study of men's health coordinated by Harvard University. Little is currently known about correlations between different types of educational interventions and peace and sustainable development. Based on available data, these correlations often appear tenuous or even non-existent. Longitudinal data can potentially help researchers and policy-makers see how the educational pathways of individuals impact decisions, behaviors, and productivity. The goal is to unearth evidence to differentiate which pathways are most likely to lead to good learning outcomes, not only in terms of educational performance measured by test scores but in life more broadly. UNESCO is anchored in a belief that education can facilitate peace and sustainable development, and longitudinal studies — made possible by EMIS data — can help reveal what educational interventions and education

journeys are most likely to maximize these desirable outcomes.

C. Social research and EMIS

In addition to improved longitudinal capabilities of EMIS, the next decade is likely to see exponential growth in "fine grain" data about teaching and learning. As data collection techniques improve and more and more learning moves to digital devices that capture and store information about the learning progression of individuals and cohorts, EMIS systems will need to be honed to facilitate the efficient capture of this information and its productive analysis. Schools around the world are experimenting with strategies to exponentially increase data collected about teaching and learning. As an example, AltSchool, a small network of private schools in the United States, uses cameras, microphones, and electronic devices worn and used by students in order to track every word, fidget, facial expression, heartbeat, click, action, and social interaction for potential research. This avalanche of data moves from classrooms into cloud-based databases where data scientists mine it to find patterns to improve learning. The data may point to the need for small-scale adjustments, such as developing techniques to ensure girls as well as boys use laboratory equipment, or larger shifts like scheduling changes to allow students to exercise more often during the school day. Founded by the former head of personalization at Google, AltSchool has been designed around a premise that novel insights can be gleaned from huge data sets and these insights will lead to structural changes in the organization and practice of education (Mead, 2016). The company is already using artificial intelligence to see trends in the data it collects. It also integrates new technology — such as sophisticated facial recognition tools, infrared cameras, and Fitbit-type wristbands that capture a student's pulse and time between meals — to further expand the raw data that can be studied. Under the AltSchool model, a data capture system strives to guide a top-to-bottom remake of education that privileges individualized learning pathways. Proponents of this approach argue that massive data sets of seemingly mundane entries from other sectors have revolutionized everything from commerce to the way professional sports are played. Drawing on this logic, EMIS have the potential to steer a transformation of teaching and learning, much in the same way detailed data capture steered the development and iterative refinement of corporate behemoths such as Alibaba, Amazon, and Netflix.

While the AltSchool may represent an extreme version of EMIS coming in the future, countries are increasingly recognizing that data must inform decision-making at the level of schools and classrooms, as well as major policy decisions deliberated by ministries of education. Governments have produced guidelines to ensure that EMIS have something for everyone and generate data that drives instructional improvement. Countries in Europe, Asia, the Americas and beyond have worked to clarify how educational data can and should be used at local levels. Generating data that is relevant to schools and teachers as well as national ministries of education improves "buy in" and compliance; if EMIS provide insights useful to individual teachers and school principals, these teachers and principals are more likely to use and update them, ensuring the accuracy of data. This trend is likely to accelerate in the coming years: EMIS will continue to collect and produce information relevant to high-level decision-makers but will increase the gathering and output of information relevant to school leaders and teachers.

As data-capturing capabilities grow, governments will need to carefully examine their costs. Building EMIS of the type used at AltSchool is prohibitively expensive (a single year of tuition costs over 20,000 USD per student), and even AltSchool leaders acknowledge that much of the company's data capture has yet to show real value in terms of guiding educational improvements. Countries with modest education budgets need to design EMIS using cost–benefit calculations, while not ignoring the potential benefits of newer technologies. The 'too-much-data' conundrum facing AltSchools is a decidedly privileged 'problem': a recent Brookings report (Custer et al., 2017) showed that while numerous governments, organizations, and companies are generating copious amounts of data to support education decision-making, many are not. Data management processes in low- and middle-income countries are often underfunded, ad hoc, and of variable quality and timeliness. Close examinations of EMIS used in countries as varied as Ghana, Mozambique and the Philippines reveal that they are not generating adequate information to monitor learning outcomes, inequality, and cost-effectiveness (DeStefano, 2011). Attempts to fix the problem with ever-more sophisticated data-gathering and reporting practices have backfired because the information is often incomplete, not properly analysed, or not acted upon (Custer et al., 2017). UNESCO is well placed to help countries perform cost–benefit analyses to guide the development of EMIS, weighing the anticipated value of different investments options. UNESCO can share lessons learned in national and regional contexts to inform decision-making in Member States.

D. Considerations related to EMIS data collection

A central challenge facing the international effort to re-orient EMIS to SDG 4 relates to privacy concerns. Privacy is the metaphorical 'elephant in the room' when it comes to anticipating the future direction of EMIS, especially within the context of wealthy countries where data-gathering techniques are already highly sophisticated. Countries have started building regulatory frameworks that seek to safeguard sensitive digital information about individuals. This work is unfolding with increased urgency as data sets grow deeper and wider, and breaches of this information become routine. Hackers have proven capable of gaining access to highly confidential information as was illustrated in 2017 when the national identification numbers, birth dates, and home addresses of up to 143 million people were stolen from Equifax, a firm that serves as a clearinghouse for credit history. Educational data are especially sensitive because they can be used to influence hiring decisions and may have repercussions in other social realms. As an example, knowledge that a particular person failed a third grade mathematics class might look insignificant at first glance, but if, say, big data analytics powered by artificial intelligence show that problems in early-grade math strongly correlate with poor professional performance and perhaps even increased instances of divorce or substance abuse, this information, if widely known or accessible, could be damaging. Each country will need to delineate how the promise of big data is balanced with respect for privacy and develop EMIS accordingly. Seemingly small decisions about EMIS software, architecture and technical protocols can reverberate loudly when deployed at state and national levels.

While large, long and interconnected data sets are excellent for educational research, questions regarding who owns this information abound. Numerous countries and municipalities have faced legal challenges and political backlash when attempting to expand and integrate EMIS. In 2014, inBloom, an NGO that offered a data warehouse solution designed to help public schools and teachers in New York integrate educational data to improve day-to-day teaching, was abandoned after two years of operation and over 100 million USD in investments (The Economist, 2014). The parent and civil society groups that championed the shutdown claimed that the system did not have adequate parental notification or consent controls and shared highly sensitive information about children in ways that could be abused. Tension over who owns data and how it can be shared are not confined to education, but because of the sensitivity of educational data and because it often involves children, the stakes are particularly high.

Countries will need to navigate these issues going forward, and regulations to protect privacy, while still in their early phases, are becoming more robust, especially in Europe where the General Data Protection Regulation (GDPR) will remake data privacy laws when enforcement begins in May 2018. GDPR will require, among other stipulations: consent of subjects for data processing, anonymization of collected data, public notifications of data breaches, and safe handling of data transfer across borders. Although GDPR is not unique to education, it is expected to cover the collection and use of EMIS data.

Some countries have seen the rise of principles and regulatory frameworks to guide privacy concerns connected to the collection and use of educational data. As an example, the United States Department of Education established a Privacy Technical Assistance Center (PTAC) which aims to function as a one-stop resource for education stakeholders to learn about data privacy, confidentiality, legal issues, and security practices related to student-level longitudinal data systems and other uses of student data. PTAC resources are tailored to help educational institutions ensure compliance with the Family Educational Rights and Privacy Act, a federal law that protects the privacy of student education records. The private sector — sensitive to legal and societal considerations surrounding the protection of children — has also created various guidelines, frameworks and protocols. The most visible of these is probably the Student Privacy Pledge which has been signed by over 300 companies including international corporations such as Google and Facebook.

Countries will need to carefully consider the privacy implications as they move to align EMIS with SDG 4. SDG 4 itself says nothing about data protection as it relates to education. Solutions are not just regulatory but extend to technology itself. Blockchain solutions are often cited as a possible technological 'fix' for privacy and security concerns surrounding learning credentials and other educational records (Keevy & Chakroun, 2018). This technology, because of the immutability of entries and absence of a centralized information warehouse, carries a potential to put individuals in greater control of their educational data. Experiments with blockchain credentialing have been carried out in a number of countries.

E. Role of EMIS in integrated decision-making

In addition to the roles of EMIS already discussed, the issue of accountability is also high on the international agenda. This can be interpreted as a response to trends

towards the decentralization of decision-making in education, and the expectation that governments are accountable to their citizens, development partners, and that they honour their international commitments. Participants during a High-Level Ministerial Panel on SDG 4, held on 1 November 2017, underscored "the need for capacity building and international assistance in indicator development, data collection, analysis, and utilization, and to build more integrated Education Management Information Systems required for Education 2030" (UNESCO, 2017). The integration of information is essential to inform decisions about the wise allocation of resources (whether human, material, or financial), potential trade-offs between investments within and between different subsectors of education and training, and for various other policy priorities. Crossing data from preschool, primary, secondary, TVET, adult learning and education, and higher education can help generate a more comprehensive understanding of student transitions within the education system and the corresponding outcomes.

Beyond learning assessment data, it will be increasingly important for countries to collect information on student satisfaction. Whereas some HEI routinely conduct surveys of student satisfaction on a range of criteria, this is less common at primary and secondary levels where students typically have less 'voice'. In addition to children and young people, the perspectives of other stakeholders such as parents, relatives, and community members are also invaluable. Whether or not institutional-level data are shared nationally, it can be beneficial to collect student feedback on their experiences of an educational programme or institution, prior to their graduation. The information provided can potentially be of value at multiple levels. Their feedback and suggestions for the future could contribute to a culture of learning and continuous improvement within programmes, institutions and the education system as a whole.

An important dimension, partly arising from the integration of Technical and Vocational Education and Training Management Information Systems (TVET-MIS) is the issue of transitions, whether between levels and types of education or between education and the world of work. Few countries have implemented successful tracking methodologies, partly because of the expense involved but also due to the difficulty engaging multiple actors, notably employers, in providing these data. Nevertheless, the success of education programmes, policies, reforms, or indeed investments cannot be fully evaluated without data on the pathways of students and graduates, some months or even years after graduation. Learning assessment data or student satisfaction surveys are not sufficient indicators of the quality and relevance of education.

As well as the satisfaction of individual learners, MoEs need to know how well education and lifelong learning systems are contributing to 'external' development objectives such as social cohesion, decent work, gender equality, and environmental sustainability. The idea that education systems should be socially accountable is relevant here. Education should be able to demonstrate its benefits to society, for example with evidence that shows that it is not simply reproducing existing social or economic inequalities. Indeed, data are needed on how education is contributing to national development policies, as well as on how SDG 4 is contributing to the other SDGs.

Governments have an obligation to report on their progress towards implementing international agreements, including normative instruments such as conventions and recommendations on education. This has often been a separate process, unrelated to the collection and dissemination of data and statistics. However, the intention is for EMIS to contain qualitative as well as quantitative information, and technological advances in data analysis make it more likely that in the future, there can be much closer interactions between national reporting based on statistics and the statutory reports submitted to the bodies responsible for monitoring the right to education. Reports on progress against development goals and targets, whether national, regional or international, and reports on the implementation of standard-setting instruments can be cross-referenced and mutually reinforcing.

F. Cloud-based computing

As trends in EMIS are so dependent on technological developments, emerging trends that are already affecting the use of data for organization and management purposes in private companies are likely to have an impact on EMIS. Among these, it is worth mentioning the opportunities offered by cloud computing, by Artificial Intelligence and its application to big data analytics. Schools and other education providers are likely to play an increasing role in collecting and processing data, for their own use as well as for the benefit of local networks of providers and the education system as a whole. School-based information platforms can increase attention to the teaching and learning processes within the institution itself and support local decision making. However, for this information to also be of use at other levels, it is important to ensure the harmonization of data categories and coding at the design stage.

With the advent of smartphones, individuals are increasingly able to input, carry, and monitor their own learning choices, participation, and outcomes. In a highly connected and networked world it is possible to imagine that individuals would be able to share their data with other learners, learning providers, and potential employers. Many of the individuals that can afford mobile technologies are already opting to share a great deal of personal information, including information about participation in education and qualifications, on social media platforms, such as Facebook, Twitter, and LinkedIn.

Cloud computing draws on combined processing power and reduces reliance on any particular user, device, or data centre. It thus provides a potentially secure place for data input, storage and analysis, and results that are simple to share between and through the web. When granted permission to access data, a wider range of stakeholders and analysts would be able to use real-time information in their work, thereby informing decision-making. However, privacy concerns are a real issue, particularly in countries where few regulations governing data use and data sharing exist.

So far, the impact on EMIS has been limited and the use of cloud computing is at an experimental stage. Nevertheless, some school districts are considering shifting their information systems to the cloud. According to the Consortium for School Networking (2017), there are multiple considerations that need to be addressed before an educational institution or network of institutions decides upon migrating data to the cloud, including a full assessment of the expected advantages and the likely costs and benefits. For several reasons the cloud may not be a feasible solution in many developing countries.

Cloud-based services require a sufficient technological, hardware, and software infrastructure, and this should be a key consideration for in resource-constrained environments. Other considerations include the likelihood of a data attack, which is higher for national or international providers than on specific school districts. Switching to cloud data and analysis requires specific expertise involving a steep learning curve, and this may take time: a strong data governance process is essential, and there are key issues about the ownership of data and the power, and accountability, of cloud providers in the process. Cloud computing can easily result in there being too much data to process in a meaningful way. Furthermore, as the access to the Internet is uneven, the benefits of migrating data to cloud will also be uneven.

The Consortium for School Networking (2017) identifies some of the key advantages of migrating education data to the cloud as:

- **Security.** Cloud-based computing systems follow a wide set of compliance and accreditation standards and security controls. Several cloud providers run on proprietary hardware and software, which are generally more difficult to hack than standardized platforms. Furthermore, data stored on the cloud are easily retrievable in case of disaster situations.
- **Simplification.** Data stored in the cloud are more easily manageable since they are found in a single location. As such, it would be easier for the ministry of education to harmonize data.
- **Analytics and Insights.** Data stored in the cloud are more easily personalized. In addition, most cloud-based services come with analytics by default, thus facilitating the generation of insights.
- **Agility.** The cloud can support short-term data-intensive research projects;
- **Efficiency.** Cloud-based computing allows different parts of the education system to share data, thus reducing costs. Furthermore, the automation of certain processes should allow education officers to focus more on higher-value work.
- **Equity.** Data stored on the cloud is more readily accessible for users across different levels of the education system, under the condition that broadband Internet access is widely available.

Advances in technology are making it possible to collect more and more data, and these new resources should enable better planning and policy formulation. Whereas previously, it was necessary for different subsystems to collect and then share data, new technologies make it more feasible to collect and analyse data organized by learners and their cohorts, rather than by the provision of learning opportunities. This is a potentially important change because, beyond matters internal to education systems, it will enable the quality, relevance, and effectiveness of education and lifelong learning to be analysed with reference to personal life trajectories, transitions, learning pathways, careers, and other development outcomes.

Cloud computing implies an enormous amount of data that can sometimes be traced to individuals. While some analytical tools are built in, the sheer quantity of data makes conventional analytical techniques appear too slow and not necessarily relevant to the questions being asked of EMIS.

Conclusions

Strong, effective EMIS are indispensable to Member States in their pursuit of inclusive and quality education and lifelong learning for all. However, as this paper has demonstrated, current conceptions of EMIS would not suffice if countries wish to maximize their gains from it and there is a need to re-orient the existing paradigm.

Section I presented these current conceptions and underlined the need to rethink them in relation to the renewed holistic focus on education and lifelong learning. There is a need to reconceptualize EMIS as a set of processes embedded within a broader system and interlinked with the other subsystems that make it up. To orient EMIS towards SDG 4, a whole-systems approach is needed; while technology is important and forms one part of the system, the competencies, social processes, and institutional arrangements that surround it are all equally integral components.

Furthermore, since education systems and the demands on it have evolved, the roles that EMIS play must also evolve. Given the increasing demands for accountability in the education sector, EMIS should therefore not only be able to make the administration of educational services efficient but should also be able to generate information that allows education actors to plan responsively for the future, make informed policy decisions, and concretely measure the success of education policies and programmes.

This section also highlighted the need to expand the range and kinds of data currently being collected by education systems. The focal shift from basic education to lifelong learning systems, from 'schooling' to 'learning', has created more complex data demands. In response, EMIS should therefore be able to provide longitudinal data on learning outcomes, in both formal and non-formal education platforms, as well as on the degree to which education systems contribute to ensuring an individual's positive participation in society.

The interconnectedness of the SDGs set forth by the 2030 Agenda requires that EMIS be able to provide and draw data from other government information systems. Since education is as one of the key pathways by which the other SDGs can be attained, cross-sectoral data are necessary for EMIS to adequately fulfil the data demands of the Sustainable Development Agenda.

Section II elaborated on the different criteria for EMIS effectiveness. Fundamentally, effective EMIS should improve upon four distinct but interrelated functional domains: (1) management and administration; (2) planning; (3) policy formulation; and (4) monitoring and evaluation. EMIS can do this by providing timely and accurate data that meet the information demands of stakeholders across the entire education system. To be able to provide such data, EMIS must possess certain prerequisite components, which were elaborated on in Section III. A key component is capacity building, which should focus on three areas in particular: technical capacity, human resources, and policies, plans, and institutional arrangements.

Building technical capacity is at once about having adequate technological infrastructure and installing mechanisms to ensure data accuracy and reliability. Both are predicated on a comprehensive and realistic needs analysis that identifies the information needs of an education system. There is no approach that will work universally for all countries; the approach to reinforcing EMIS needs to be informed by country contexts.

Human resources are also an important consideration in capacity-building for EMIS, as collecting, analysing, and interpreting the data contained in EMIS are all performed by MoE staff. Incapable staff therefore means ineffective EMIS. MoEs must ensure that they recruit qualified staff and that they train staff on EMIS functionalities. Many EMIS reinforcement initiatives have neglected this area of capacity-building, resulting in MoEs being overly dependent on external EMIS providers. It is also important to build competencies not only at the central level, but also at the regional, district, and school levels, especially given the general trend towards decentralization in the education sector. In addition, since EMIS basically democratizes access to education data, ministries of education must communicate with external stakeholders on how to responsibly report and interpret education data.

Policies, plans, and institutional arrangements are an equally essential element of capacity-building, as the culture and structures of an institution serve as the enabling environment for EMIS. Ministries of education must ensure that there is a unit dedicated to administering and maintaining EMIS but must do so while preventing silos from forming within the organization. Coordination and interdependence are vital. To institutionalize these practices, ministries of education should develop the corresponding legal and policy frameworks. Such legal and policy frameworks also allow ministries of education to cement a shared vision and understanding of EMIS across the entire organization.

Section III expanded on UNESCO's role in the future development of EMIS. Given UNESCO's position as the agency responsible for SDG 4, and the Organization's extensive experience in providing education policy and implementation advice to Member States, UNESCO possesses the expertise needed to assist countries in building their technical, human, and institutional capacities, for the purpose of developing an EMIS that responds to the demands of SDG 4-Education 2030. Moreover, UNESCO's vast network allows it to facilitate peer learning among ministries of education and mobilize partners and external experts to collaborate on efforts to strengthen EMIS. As the main platform by which education policy norms and standards are discussed and agreed upon by Member States, UNESCO is also well positioned to set an agenda with standards for reinforcing and developing EMIS. UNESCO is therefore a critical partner in augmenting the capacities of Member States towards supporting the re-orientation of EMIS towards inclusive and equitable quality education and lifelong learning.

Section IV looked at the future of EMIS and discussed how EMIS can be very powerful tools in the pursuit of SDG 4. In an era when stakeholders are demanding greater accountability from their governments, EMIS allow ministries of education to measure and accelerate their progress towards development objectives at the local, national, and international levels. However, the expansion from MDG 2's original focus on basic education to SDG 4-Education 2030's broader focus on lifelong learning means that EMIS will need to collect and analyse data across time. Such EMIS expansions include Non-Formal Education Management Information Systems (NF-EMIS) and Community-Based Education Management Information Systems.

EMIS must also enable education systems to contribute to other distinct but interconnected areas of national development, such as employment, health, and poverty alleviation. This integration of EMIS with other government information systems is particularly important, given how the SDGs are tightly interlinked. Closer coordination across government ministries will be needed to achieve this interoperability.

Ministries of education can take advantage of technological developments to augment the capabilities of their EMIS. For instance, they can look to big data analytics, mobile applications and artificial intelligence as possible platforms for improving EMIS while addressing privacy and other concerns.

Quick developments in information technology underline the need for EMIS to be dynamic and flexible; they should be able to readily incorporate new methodologies and technologies for data gathering and data analysis. As such, strengthening EMIS becomes a highly iterative process. UNESCO, as the laboratory for ideas and innovation in education and lifelong learning, plays an invaluable role in helping countries critically determine how emerging technologies can best help them advance towards achieving SDG 4 targets, in the context of EMIS policies and plans. In so doing, UNESCO can act as a clearinghouse that brokers impartial policy advice and technical assistance to Member States.

In conclusion, in line with the new international education agenda, there needs to be a paradigm shift in how education systems use data to operate educational institutions, develop education plans and agendas, implement policies and programmes, and gauge their performance. For EMIS to retain their effectiveness, they should evolve in sync with the paradigm shift of 'schooling' to 'learning'. While SDG 4 incorporates some of the components of Education for All that are still underway, it places a clear premium on aspects of education that are difficult to measure, such as inclusion, equity, quality and relevance, processes, outputs and outcomes. Effective and sustainable EMIS cannot be static in design but must be responsive, flexible, and sufficiently broad to adjust to evolving data needs.

UNESCO, as the agency leading efforts towards the achievement of SDG 4, plays a central role in assisting countries in contextualizing their vision for EMIS to their needs and realities on the ground. UNESCO recognizes its responsibility to pioneer the dialogue and shift the paradigm on EMIS in line with the evolving education landscape. Together with other development partners, UNESCO seeks to empower educational leaders in measuring the progress of their respective countries towards SDG 4 targets, and in implementing more responsive and more inclusive and equitable policies, plans and programmes.

References

Abdul-Hamid, H. 2014. *What matters most for Education Management Information Systems: a framework paper*. The World Bank. Retrieved from http://wbgfiles.worldbank.org/documents/hdn/ed/saber/supporting_doc/Background/EMIS/Framework_SABER-EMIS.pdf

Abdul-Hamid, H., Saraogi, N. and Mintz, S. 2017. *Lessons Learned from World Bank Education Management Information System Operations.* Retrieved from https://openknowledge.worldbank.org/bitstream/handle/10986/26330/9781464810565.pdf?sequence=2

Adam, L. 2011. How can holistic Education Management Information Systems Improve Education? [Blog post]. Retrieved from http://edutechdebate.org/education-management-information-systems/how-can-holistic-education-management-information-systems-improve-education/

Braa, J., Hanseth, O., Heywood, A., Mohammed, W. and Shaw, V. 2007. Developing health information systems in developing countries: the flexible standards strategy. *Mis Quarterly*, pp. 381–402. Retrieved from http://heim.ifi.uio.no/~oleha/Publications/FlexibleStandards.pdf

Braa, J., Monteiro, E. and Sahay, S. 2004. Networks of action: sustainable health information systems across developing countries. *MIS quarterly*, pp. 337–362. Retrieved from https://www.researchgate.net/profile/Eric_Monteiro2/publication/220260083_Networks_of_Action_Sustainable_Health_Information_Systems_Across_Developing_Countries/links/00b49525816271b03e000000/Networks-of-Action-Sustainable-Health-Information-Systems-Across-Developing-Countries.pdf

Carrizo, L., Sauvageot, C. and Bella, N. 2003. *Information tools for the preparation and monitoring of education plans.* UNESCO. Retrieved from http://unesdoc.unesco.org/images/0013/001323/132306e.pdf

Cassidy, T. 2006. *Education Management Information System (EMIS) Development in Latin America and the Caribbean: Lessons and Challenges.* Inter-American Development Bank. Retrieved from https://publications.iadb.org/handle/11319/2769?locale-attribute=en

Chen, Y. N., Chen, H. M., Huang, W., & Ching, R. K. 2006. E-government strategies in developed and developing countries: An implementation framework and case study. *Journal of Global Information Management*, Vol. 14(1), pp. 23. Retrieved from https://pdfs.semanticscholar.org/eb62/b748387cbf03193e600de578b192c47fcaa4.pdf

Chen, Y. and Li, H. 2009. Mother's education and child health: Is there a nurturing effect? *Journal of Health Economics*, Vol. 28(2), pp. 413–426. Retrieved from https://reap.fsi.stanford.edu/sites/default/files/1-s2.0-s0167629608001537-main.pdf

Cleland, J. G. and Van Ginneken, J. K. 1988. Maternal education and child survival in developing countries: the search for pathways of influence. *Social science & medicine*, Vol. 27(12), pp. 1357–1368. Retrieved from https://www.researchgate.net/profile/John_Cleland/publication/20085046_Maternal_Education_and_Child_Survival_in_Developing_Countries/links/59dd0e8aaca27218a7605a9c/Maternal-Education-and-Child-Survival-in-Developing-Countries.pdf

Consortium for School Networking (n.d.) *Why Cloud?* Retrieved from http://www.cosn.org/sites/default/files/Why%20Cloud.pdf

Custer, S., King, E., Manuelyan Atinc, T., Read, L. and Sethi, T. 2018. Towards data-driven Education Systems: Insights into using information to measure results and manage change. Brookings Center for Universal Education. Retrieved from https://www.brookings.edu/wp-content/uploads/2018/02/toward-data-driven-education-systems.pdf

De Silva, S. and Valsangkar, P. 2015. The impact of education management information systems: the case of Afghanistan [Blog post]. Retrieved from http://blogs.worldbank.org/education/impact-education-management-information-systems-case-afghanistanDesai, S., & Alva, S. 1998. Maternal education and child health: Is there a strong causal relationship?. *Demography*, Vol. 35(1), pp. 71–81. Retrieved from http://sonaldedesai.org/maternal_education_and.pdf

DeStefano, J. 2011. Information for Education Policy, Planning, and Management: Summary of the Data Capacity Assessments Conducted in the Philippines, Ghana, and Mozambique. Research Triangle Park, NC: RTI International

Ebrahim, Z. and Irani, Z. 2005. E-government adoption: architecture and barriers. *Business process management journal*, Vol. 11(5), pp. 589–611.

Retrieved from http://www.emeraldinsight.com/doi/pdfplus/10.1108/14637150510619902

Edmunds, A.and Morris, A. 2000. The problem of information overload in business organisations: a review of the literature. *International journal of information management*, Vol. 20(1), pp. 17–28. Retrieved from http://ai2-s2-pdfs.s3.amazonaws.com/6800/bb68f4ad39f8a712c7e0ba8a0f00876b9f58.pdf

Economist Magazine. 2014. Big data and education: Withered inBloom. Retrieved from https://www.economist.com/blogs/schumpeter/2014/04/big-data-and-education

Fonner, V. A., Armstrong, K. S., Kennedy, C. E., O'Reilly, K. R. and Sweat, M. D. 2014. School based sex education and HIV prevention in low-and middle-income countries: a systematic review and meta-analysis. *PloS one*, *9*(3), e89692. Retrieved from http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0089692

Heeks, R. 2002. Information systems and developing countries: Failure, success, and local improvisations. *The information society*, Vol. 18(2), pp. 101–112. Retrieved from http://dx.doi.org/10.1080/01972240290075039

Herold, B. 2018. Schools, Government Agencies Move to Share Student Data: Linking children's personal records shows promise, raises questions. Education Week.

Hua, H. 2011. EMIS development in a new era [Blog post]. Retrieved from http://edutechdebate.org/education-management-information-systems/emis-development-in-a-new-era/

Hua, H. and Herstein, J. 2003. Education management information system (EMIS): Integrated data and information systems and their implications in educational management. In *annual conference of comparative and International Education Society* (p. 26). Retrieved from http://www.infodev.org/infodev-files/resource/InfodevDocuments_188.pdf

Kenn, G.C. 2016. Education, skills, and decent work in low and middle income countries: Trends and results from an adult skills survey. *Paper commissioned for the Global Education Monitoring Report 2016, Education for people and planet: Creating sustainable futures for all*. UNESCO. Retrieved from http://unesdoc.unesco.org/images/0024/002456/245622E.pdf

Keevy, J. and Chakroun, B. 2018. Digitisation of Credentials: Implications for the Recognition of Learning. Manuscript in preparation.

Kirby, D., Obasi, A. and Laris, B. A. 2006. The effectiveness of sex education and HIV education interventions in schools in developing countries. *Technical Report Series-World Health Organization*, *938*, 103. Retrieved from http://www.who.int/immunization/hpv/target/preventing_hivaids_in_young_people_unaids_who_2006.pdf#page=112

Levin, B. 2004. Media–government relations in education. *Journal of Education Policy*, Vol. 19(3), pp. 271–283. Retrieved from http://www.tandfonline.com/doi/full/10.1080/0268093042000207610

Lovely, J. 2011. Education Management Information Systems in Africa (and elsewhere) [Blog post]. Retrieved from http://edutechdebate.org/education-management-information-systems/educational-management-information-systems-in-africa-and-elsewhere/

Mockler, N. 2013. Reporting the 'education revolution': MySchool.edu.au in the print media. *Discourse: Studies in the cultural politics of education*, Vol. *34*(1), pp. 1–16. Retrieved from http://www.tandfonline.com/doi/abs/10.1080/01596306.2012.698860

Mead, R. 2016. Learn Different: Silicon Valley disrupts education. New Yorker Magazine. Retrieved from https://www.newyorker.com/magazine/2016/03/07/altschools-disrupted-education

OECD. 2015. *Data-Driven Innovation: Big Data for Growth and Well-Being*. OECD Publishing, Paris. Retrieved from https://www.oecd.org/sti/inno/data-driven-innovation-interim-synthesis.pdf

Sparreboom, T. and Staneva, A. 2014. Is education the solution to decent work for youth in developing economies: Identifying qualifications mismatch from 28 school-to-work transition surveys. *Work4Youth Publication Series No. 23*. Geneva: International Labour Organization. Retrieved from http://www.un.org/youthenvoy/wp-content/uploads/2014/10/Work4Youth-Publication.pdf

Porta, E. and Arcia, G. 2011. *Improving information systems for planning and policy dialogue: The SABER EMIS Assessment Tool.* The World Bank. Retrieved from http://siteresources.worldbank.org/EDUCATION/Resources/278200-1290520949227/7575842-1299512073351/SABEREMIS.pdf

Tung, K.C. 2003. Preamble. In: Wako, 2003. *Education Management Information Systems (EMIS)*. Harare. Fontline Electronic Publishing.

United Nations General Assembly. 2015. *Transforming our world: the 2030 Agenda for Sustainable Development,* GA Res 70/1, UNGAOR, 70th Sess, UN Doc A/RES/70/1 (25 September 2015). Retrieved from http://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E

UNESCO. 1960. *Convention against Discrimination in Education*, Paris, 14 December 1960, available at http://portal.unesco.org/en/ev.php-URL_ID=12949&URL_DO=DO_TOPIC&URL_SECTION=201.html

———. 2012. Guidelines for Capacity Development in Education Policy Planning and Resource Management. Retrieved from http://unesdoc.unesco.org/images/0022/002202/220274e.pdf

———, 2013a. Executive Board, *Implementation of Standard-Setting Instruments — Part I: General Monitoring*, 192 EX/20 Part I (31 July 2013), available at http://unesdoc.unesco.org/images/0022/002223/222315e.pdf#page=9

———. 2013b. *UNESCO Handbook on Education Policy Analysis and Programming, Volume 1*. Bangkok: UNESCO. Retrieved from http://unesdoc.unesco.org/images/0022/002211/221189E.pdf

———. 2017. *Unpacking Sustainable Development Goal 4-Education 2030.* Retrieved from http://unesdoc.unesco.org/images/0024/002463/246300E.pdfUNESCO International Institute for Education Planning. 2012. Module 1: Characteristics of the Educational Management Information System [Course material].

———. Glossary: Education Management Information System (EMIS). Retrieved from https://at.iiep.unesco.org/glossaryEMIS.

UNESCO Institute for Statistics. 2017. *UIS Theory of Change.* Retrieved from http://uis.unesco.org/sites/default/files/documents/uis-theory-of-change.pdf

———. 2018a. *Concept Note: The Investment Case for SDG 4 Data.* Dubai: UNESCO. Retrieved from http://uis.unesco.org/sites/default/files/documents/investment-case-SDG 4-data.pdf

———. 2018b . *Concept Note: Towards an Innovative Demand-Driven Global Strategy for Education Data.* Montreal: UIS. Retrieved from http://uis.unesco.org/sites/default/files/documents/towards-innovative-demand-driven-global-strategy-education-data-2018-en.pdf

UNICEF. 2016. *Technical Guidance: Guide for Including Disability in Education Management Information Systems.* Retrieved from https://www.openemis.org/files/resources/UNICEF_Guide_for_Including_Disability_in_Education_Management_Information_Systems_2016_en.pdf

UNICEF and UIS. 2016. *Monitoring Education Participation: Framework for Monitoring Children who are Out of School or at Risk of Dropping Out.* Retrieved from http://uis.unesco.org/sites/default/files/documents/monitoring-education-participation.pdf

Villanueva, C. 2003. *Education Management Information System and the formulation of Education for All: Plan of Action 2002-2015.* Almaty: UNESCO. Retrieved from http://unesdoc.unesco.org/images/0015/001568/156818eo.pdf

Williams, J.R.A. 2004. «Quality information for a quality early childhood care and development » *UNESCO policy brief on early childhood; 25* UNESCO. Retrieved from http://unesdoc.unesco.org/images/0013/001374/137414e.pdf

Wood, J. 2011. Let us prioritise investment in Education Management Information Systems [Blog post]. Retrieved from http://edutechdebate.org/education-management-information-systems/let-us-prioritise-investment-in-education-management-information-systems/

World Bank. 2015. *Improving student learning through informed decisions: the role of Education Management Information Systems.* Retrieved from http://documents.worldbank.org/curated/en/529131468338532010/pdf/955550BRI0Box300Notes0EMIS00PUBLIC0.pdf

———. 2016. *Education Management Information Systems.* Retrieved from http://wbgfiles.worldbank.org/documents/hdn/ed/saber/supporting_doc/brief/SABER_EMS_Brief.pdf

World Bank and UIS. 2004. *A framework for assessing the quality of education statistics.* Retrieved from https://unstats.un.org/unsd/dnss/docs-nqaf/WB-UNESCO-DQAF%20for%20education%20statistics.pdf

Appendix A

List of SDG 4 Targets and Indicators

SDG 4, 'Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all'

Target 4.1 By 2030, ensure that all girls and boys complete free, equitable and quality primary and secondary education leading to relevant and effective learning outcomes	
4.1.1	Proportion of children and young people (a) in Grade 2 or 3; (b) at the end of primary education; and (c) at the end of lower secondary education achieving at least a minimum proficiency level in (i) reading and (ii) mathematics, by sex
4.1.2	Administration of a nationally-representative learning assessment (a) in Grade 2 or 3; (b) at the end of primary education; and (c) at the end of lower secondary education
4.1.3	Gross intake ratio to the last grade (primary education, lower secondary education)
4.1.4	Completion rate (primary education, lower secondary education, upper secondary education)
4.1.5	Out-of-school rate (primary education, lower secondary education, upper secondary education)
4.1.6	Percentage of children over-age for grade (primary education, lower secondary education)
4.1.7	Number of years of (a) free and (b) compulsory primary and secondary education guaranteed in legal frameworks
Target 4.2 By 2030, ensure that all girls and boys have access to quality early childhood development, care, and pre-primary education so that they are ready for primary education	
4.2.1	Proportion of children under 5 years of age who are developmentally on track in health, learning, and psychosocial well-being, by sex
4.2.2	Participation rate in organized learning (one year before the official primary entry age), by sex
4.2.3	Percentage of children under 5 years experiencing positive and stimulating home learning environments
4.2.4	Gross early childhood education enrolment ratio in (a) pre-primary education and (b) and early childhood educational development
4.2.5	Number of years of (a) free and (b) compulsory pre-primary education guaranteed in legal frameworks
Target 4.3 By 2030, ensure equal access for all women and men to affordable quality technical, vocational, and tertiary education, including university	
4.3.1	Participation rate of youth and adults in formal and non-formal education and training in the previous 12 months, by sex
4.3.2	Gross enrolment ratio for tertiary education by sex
4.3.3	Participation rate in technical-vocational programmes (15- to 24-year-olds) by sex
Target 4.4 By 2030, substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs, and entrepreneurship	
4.4.1	Proportion of youth and adults with information and communications technology (ICT) skills, by type of skill
4.4.2	Percentage of youth/adults who have achieved at least a minimum level of proficiency in digital literacy skills
4.4.3	Youth/adult educational attainment rates by age group, economic activity status, levels of education, and programme orientation
Target 4.5 By 2030, eliminate gender disparities in education and ensure equal access to all levels of education and vocational training for the vulnerable, including persons with disabilities, indigenous peoples and children in vulnerable situations	
4.5.1	Parity indices (female/male, rural/urban, bottom/top wealth quintile and others such as disability status, indigenous peoples and conflict-affected, as data become available) for all education indicators on this list that can be disaggregated
4.5.2	Percentage of students in primary education whose first or home language is the language of instruction
4.5.3	Extent to which explicit formula-based policies reallocate education resources to disadvantaged populations
4.5.4	Education expenditure per student by level of education and source of funding
4.5.5	Percentage of total aid to education allocated to least developed countries
Target 4.6 By 2030, ensure that all youth and a substantial proportion of adults, both men and women, achieve literacy and numeracy	
4.6.1	Proportion of population in a given age group achieving at least a fixed level of proficiency in functional (a) literacy and (b) numeracy skills, by sex
4.6.2	Youth/adult literacy rate
4.6.3	Participation rate of illiterate youth/adults in literacy programmes

Target 4.7 By 2030, ensure all learners acquire knowledge and skills needed to promote sustainable development, including among others through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship, and appreciation of cultural diversity and of culture's contribution to sustainable development	
4.7.1	Extent to which (i) global citizenship education and (ii) education for sustainable development, including gender equality and human rights, are mainstreamed at all levels in: (a) national education policies, (b) curricula, (c) teacher education, and (d) student assessment
4.7.2	Percentage of schools that provide life skills-based HIV and sexuality education
4.7.3	Extent to which the framework on the World Programme on Human Rights Education is implemented nationally (as per the UNGA Resolution 59/113)
4.7.4	Percentage of students by age group (or education level) showing adequate understanding of issues relating to global citizenship and sustainability
4.7.5	Percentage of 15-year-old students showing proficiency in knowledge of environmental science and geoscience
Target 4.a Build and upgrade education facilities that are child, disability, and gender-sensitive and provide safe, non-violent, inclusive and effective learning environments for all	
4.a.1	Proportion of schools with access to: (a) electricity; (b) Internet for pedagogical purposes; and (c) computers for pedagogical purposes (d) adapted infrastructure and materials for students with disabilities; (e) basic drinking water; (f) single-sex basic sanitation facilities; and (g) basic handwashing facilities (as per the WASH indicator definitions)
4.a.2	Percentage of students experiencing bullying, corporal punishment, harassment, violence, sexual discrimination, and abuse
4.a.3	Number of attacks on students, personnel and institutions
Target 4.b By 2020, substantially expand globally the number of scholarships available to developing countries, in particular least developed countries, small island developing States and African countries, for enrolment in higher education, including vocational training, information and communications technology, technical, engineering, and scientific programmes in developed countries and other developing countries	
4.b.1	Volume of official development assistance flows for scholarships by sector and type of study
4.b.2	Number of higher education scholarships awarded, by beneficiary country
Target 4.c By 2030, substantially increase the supply of qualified teachers, including through international cooperation for teacher training in developing countries, especially least developed countries and small island developing States	
4.c.1	Proportion of teachers in: (a) pre-primary education; (b) primary education; (c) lower secondary education; and (d) upper secondary education who have received at least the minimum organized teacher training (e.g. pedagogical training) pre-service or in-service required for teaching at the relevant level in a given country, by sex
4.c.2	Pupil-trained teacher ratio by education level
4.c.3	Proportion of teachers qualified according to national standards by education level and type of institution
4.c.4	Pupil-qualified teacher ratio by education level
4.c.5	Average teacher salary relative to other professions requiring a comparable level of qualification
4.c.6	Teacher attrition rate by education level
4.c.7	Percentage of teachers who received in-service training in the last 12 months by type of training

Appendix B

StatEduc in Burkina Faso

Case Study: StatEduc[1] in Burkina Faso's Ministry of Basic Education and Literacy

This case study is part of a UNESCO Working Paper titled "Orienting Education Management Information Systems (EMIS) towards inclusive and equitable quality education and lifelong learning".

In 1996, the Government of Burkina Faso affirmed basic education as a priority development area, therein creating a comprehensive plan for the education sector called the *Plan Décennal de Développement de l'Éducation de Base* (PDDEB). This plan, formally adopted in 1999, was established, first and foremost, to expand access to education, improve quality of education, and address high levels of illiteracy in the country.

The Ministry of Basic Education and Literacy (*Ministère de l'Enseignement de Base et de l'Alphabétisation*, MEBA) recognized that, to realize the objectives set in the PDDEB, it needed a way to concretely measure the attainment of education outcomes. In light of this, MEBA, in 2000, designated its Directorate for Research and Planning (*Direction des* Études *et de la Planification*, DEP) to develop a software to automate the collection, analysis, production, and dissemination of statistics for basic education.

This initiative came at an opportune moment, as it was accompanied by a general wave of transparency-driven reform in the government brought about by the Project to Develop a National Statistical System (*Projet de Développement du Système Statistique National*, PDSSN) and the Project to Support Statistical Capacity-Building in Burkina Faso (*Projet d'Appui au Renforcement des Capacités Statistiques du Burkina Faso*, ARCS). These projects were made possible through the technical and financial support of the World Bank and the European Union (EU).

Implementation and System Features

Having identified the installation of EMIS software as a critical step toward the achievement of the goals established by the 2000 Dakar Framework for Action, MEBA sought the assistance of UNESCO to conduct a thorough diagnostic analysis of their current system. The diagnostic analysis examined infrastructure, institutional capacity, human resource capacity, and existing processes.

This analysis identified four principal pain points in the current system: (1) weak integration in institutions; (2) weak infrastructure; (3) inadequate human resource capacity; and (4) weak data quality.

At the time of diagnosis, there was no specific unit in charge of managing education statistics. In addition, education data did not harmonize with national data from other sectors of government. This lack of integration was even more problematic, given that MEBAis structured such that multiple governmental units were involved in various aspects of education delivery, namely:

- the Directorate for Administrative and Financial Affairs (*la Direction des Affaires Administratives et Financières*);
- the Directorate for Human Resources (*la Direction des Ressources Humaines*);
- the General Directorate for Literacy and Non-Formal Education (*la Direction Générale de l'Alphabétisation et de l'Éducation Non-Formelle*);
- the Directorate for Examinations and Certifications (*la Direction des Examens et des Concours*);
- the General Directorate for Basic Education (l*a Direction Générale de l'Enseignement de Base*);
- the Directorate for the Allocation of Special Budgets for Schools (*la Direction de l'Allocation des Moyens Spécifiques aux Écoles*);
- the Regional Directorates for Basic Education and Literacy (*les Directions Régionales de l'Enseignement de Base et de l'Alphabétisation*); and
- the Provincial Directorates for Basic Education and Literacy (*les Directions Provinciales de l'Enseignement de Base et de l'Alphabétisation*).

Different units generated their own data sets, which would often be discrepant with each other. From a more general standpoint, there was no data use culture in the Ministry. Data was rarely used in the planning process and in decision-making.

Infrastructure was also weak, with Ministry units, especially those located in regions and provinces, lacking computers, logistical equipment to collect and process data, or a suitable Internet connection. As such, most of the data were manually inputted and analyzed. These manual processes were therefore more likely to result in erroneous reporting,

1 StatEduc is an EMIS Builder software developed by UIS in cooperation with EU, ADEA, and Sub-Saharan African Countries

either by human error or by deliberate data tampering. Since there was also no data validation mechanism in place, erroneous reporting would also be left unchecked. Manual data processing also resulted in long lead times, with statistical yearbooks taking two years to be produced.

Human resource capacity was also a key issue. First, there was a lack of qualified personnel; the number of employees was insufficient, given the new tasks that would accompany the installation of a new system. This also meant that there were competency gaps in statistics and in information technology that would have hindered the effective use of the new software, if left unaddressed.

Thus, having identified these pain points through the diagnostic analysis, MEBA and UNESCO made sure to address them through the course of EMIS software implementation. In effect, the diagnosis served as a needs analysis for MEBA, prior to actual implementation.

To harmonize data collection, analysis, production, and dissemination, MEBA assigned DEP to be the institutional home of StatEduc, Burkina Faso's EMIS software. As the unit in charge of EMIS, DEP triggers the data collection process. DEP notifies Regional Directorates that data collection has begun, after which the Regional Directorates mobilize the Provincial Directorates under their area of supervision. The Provincial Directorates then compile data submitted by individual schools in their respective provinces. Provincial education data are then transmitted to the Regional Directorates to be collated, and then to DEP for analysis. MEBA also shares technical resources with the Ministry for Secondary and Higher Education (*Ministère des Enseignements Secondaire et Supérieur,* MESS) – the ministry responsible for post-primary education – allowing these two government agencies to synchronize their processes. MESS also uses StatEduc for their EMIS, making synchronization easier.

Since not all offices have access to a stable and reliable Internet connection, StatEduc was configured such that it can function both offline and online. In areas with poor Internet connection, StatEduc functions on a local network where data are uploaded to a local server. To transmit them online, the data are transported (for instance, via USB) to an area with a serviceable Internet connection, where they can then be uploaded online. For schools that have no electricity, on the other hand, data are manually transcribed and then sent to the Regional Directorate for inputting into StatEduc.

To ensure that data are accurate, the government installed certain validation mechanisms. The software was designed with a functionality to detect suspect data and to alert such data to system administrators upon detection. There is also a National Statistical Law that renders all data falsification legally punishable. In the case of education data, the designated Regional MEBA staff and the corresponding Provincial Director, as co-signatories, are legally accountable for the accuracy of all data they transmit to the central MEBA office. Furthermore, the people involved in validating data were provided a manual and corresponding training. The National Statistical Law also requires all entities to submit data to the government, if requested to do so – thus also acting as a compliance mechanism.

Of course, StatEduc could not function well if users and administrators did not possess adequate competencies in statistics and in the use of IT. Recognizing this, MEBA and its development partners invested in several capacity-building initiatives to bring current employee competencies to adequate levels. The Technical Specialist hired to guide the strengthening of Burkina Faso's EMIS was also tasked to train employees in the use and administration of StatEduc. In addition, MEBA dedicated significant resources towards the recruitment of statisticians and IT specialists in DEP.

Since StatEduc's first implementation, financial resources have been annually programmed towards training users and administrators, data collection and validation, and system maintenance. This provision of an annual budget for EMIS-related initiatives has certainly contributed towards the institutionalization of the system. However, MEBA is yet to create a policy that formalizes this practice; as of writing, the annual EMIS budget is only programmed as a requirement of MEBA's development partners (UNESCO, EU, World Bank). These development partners have made their continued financing of education projects contingent on MEBA's submission of data every year.

MEBA and its development partners obtained this kind of support from the national government through various initiatives aiming to obtain executive buy-in. The implementation team aligned key messaging for EMIS with the objectives laid out in the National Strategy for the Development of Statistics, a critical government reform. In addition, the findings of the diagnostic analysis were presented in the "*Réunion Nationale de Restitution*" to collaboratively develop solutions to identified pain points. Education indicators were also decided in this national government meeting.

At the time of writing, StatEduc is able to generate the following key education outcome reports:

- **Statistical yearbook.** The statistical yearbook is an annually published document that provides an overview of the current state of formal and non-formal education in

Burkina Faso. It includes aggregated statistics on general education statistics such as enrolment and completion.

- **Time-series yearbook.** The time-series yearbook compiles data from statistical yearbooks across time, allowing stakeholders and policy-makers to track progress in education outcomes through the years.
- **Evaluation report on educational achievement.** This evaluation report examines the attainment of desired learning outcomes, aggregating data from different regions.
- **School report card.** The system can disaggregate data to the school level, allowing stakeholders and policy-makers to identify high- and low-performing schools and subsequently address the needs of these schools in a more responsive manner.

These reports are currently used by MEBA to inform the entire policy cycle – from determining priority actions during planning to monitoring and evaluating the attainment of objectives after the execution of specific policies and programmes.

Burkina Faso's EMIS automation has seen major gains in efficiency. Burkina Faso is now able to generate timely, reliable, and regular education statistics. After the installation of StatEduc, MEBA now produces statistical yearbooks within a lead time of eight to nine months — a large improvement compared to the previous two-year lead time. There have also been major gains in terms of institutional and human resource capacity, with MEBA now having qualified and trained personnel in charge of EMIS.

Therefore, generally speaking, the implementation of EMIS in Burkina Faso presents various best practice elements, which may be useful for other countries that are looking to strengthen their own EMIS as well.

Best Practice Elements in Implementation

The success of EMIS implementation in Burkina Faso is primarily due to the fact that the system was configured and adapted to the needs of the country's education system. As such, the first best practice element that can be established from the Burkina Faso experience is the conduct of a diagnostic analysis prior to actual implementation. A diagnostic analysis provides a realistic view of the current system and thus allows project implementers to determine appropriate next steps based on the ministry of education's current capacities, be it in terms of infrastructure, competencies, data quality, or institutional processes. For instance, it is the conduct of a diagnostic analysis that led MEBA to design an EMIS that incorporates both online and offline methods of data collection. This cohabitation of technologies allowed MEBA to capture data from all areas of Burkina Faso — even areas with limited or no Internet connectivity.

Anchoring EMIS implementation on a capacity development approach is another best practice element from the Burkina Faso experience. The implementation team for Burkina Faso ensured that MEBA could independently run their EMIS by augmenting the competency levels of MEBA staff. This was done either through the conduct of formal training and coaching sessions or through the recruitment of qualified personnel. A capacity development approach ensures that EMIS can become more sustainable, as ministries of education do not depend on external consultants for the production, analysis, and dissemination of education statistics.

Capacity development in Burkina Faso was not limited to augmenting human resource capacity. The implementation team also considered institutional capacity — that is, they examined the existing institutional processes, identified procedural gaps, and developed mechanisms that would bridge those gaps. One such critical mechanism installed for Burkina Faso was their data validation mechanism. Acting as a significant deterrent is the software's ability to automatically detect and signal potentially erroneous data. The presence of the National Statistical Law, which designates specific people accountable for data accuracy, also greatly deters falsification and tampering of data.

The designation of DEP as the institutional 'home' of EMIS was also critical to implementation success. This decision not only reinforced accountability but also strengthened the sustainability of the system. It helped MEBA harmonize its data, which, before the project, originated from different sources and were thus often discrepant with each other. DEP, as the institutional home, became accountable not only for the integrity of the education statistics they produced but also for the integrity of the larger information system.

The execution of these initiatives was possible because the Ministry of Education allocated a regular yearly budget for EMIS. The implementation team required MEBA to shoulder counterpart costs. This not only assures consistent financing for the system but it also creates a greater sense of ownership from the Ministry. However, as mentioned in the previous section, the allocation of this yearly budget is yet to be institutionalized in an actual policy document. Therefore, the creation of such a policy is be a critical next step for Burkina Faso.

These next steps can be attained through further efforts in obtaining executive buy-in. The implementation team needs only to build on previous initiatives that enlisted the support of top decision-makers. The team should continue to engage top management in participatory dialogues and involve them in decision-making. This approach proved effective in the earlier stages of EMIS implementation, wherein the team presented their diagnosis of the current system and involved key executives in determining principal objectives and corresponding next steps.

The approach taken by the implementation team was systemic. In implementing EMIS, the team considered the technology available at different levels of Burkina Faso's Ministry of Education, the competencies of users and system administrators, the processes currently in place, and the broader institutional culture. EMIS implementation is more likely to succeed if all aspects of the system are addressed.

Moving Forward

The prospective developments proposed in this section also consider the entire system. The different components of an EMIS are interrelated, and as such, an improvement in one component necessitates corresponding improvements in other components.

The most immediate possible improvement in Burkina Faso's EMIS would be to increase data coverage for private schools; the coverage rate is relatively low, compared to public schools. At the moment, there is relatively little data available on private educational institutions

To improve data collection from private schools, MEBA can develop a communication plan that will help them convey how these institutions can benefit from full inclusion in StatEduc. This communication plan should incorporate national consultations that would engage private education providers in education policy dialogues. This way, the private sector cooperates with the government not merely out of legal compliance, but out of buy-in and voluntary participation. This is more likely to engender sustained cooperation between private and public educational institutions.

Internally, MEBA can also aim for further harmonization within the education sector. While MEBA has already harmonized majority of the data coming from the different units involved in education, there is still room for further integration of with other education subset data, including information on education finance, learning assessment data, the examination database, and the development of Geographical Information System (GIS) to improve the school mapping.

MEBA can also invest in School Management Information Systems that directly integrate with the larger national EMIS. At the time of writing, schools do not have access to their own information system; they are only involved with EMIS insofar as submitting data to MEBA. Schools, however, can draw more value from EMIS if they can also derive immediate benefits from the system. Establishing an SMIS for individual schools empowers schools, allowing them to self-manage and thus better adapt their practices to the needs of their local communities. Providing schools with the ability to monitor and plan for themselves is in itself an incentive to regularly update their data; this would therefore facilitate data collection at the regional and national levels. The creation of a Student Registration System that attributes a unique identification number to each student would also help schools manage themselves more autonomously. This would allow schools to monitor learning outcomes for individual students, as well as identify students at risk. Once available, this data can also be aggregated to surface broader education policy concerns, such as access-related inequities and risks factors for dropping out, among others.

Infrastructural constraints do exist: as such, the installation of SMIS requires investment in local infrastructure, often outside the domain of ministries of education. Nonetheless, MEBA can prepare for this development by providing school leaders with training in statistics. In any case, augmenting the statistical proficiency of school leaders, even before an SMIS is put in place, will still be useful from a school-based management standpoint.

Over the longer term, the country could move towards the development of a sectoral information management system covering all education subsector data through the integration of databases from MEBA and the Ministry of Secondary and Higher Education. This sectoral system can be connected with information systems used by other government agencies in Burkina Faso (such as the Public Service human resource management database, the payroll database, the employment database, vital statistics, and demographic database). This means beginning the process of synchronizing data with other sectors. This would allow MEBA to generate intersectoral analyses, linking education outcomes with labor outcomes, for instance. Naturally, this would entail harmonization efforts at the level of the national government, and would also depend on the readiness of information systems used by other government agencies. Nonetheless, MEBA can prepare EMIS

for future integration by coordinating with other ministries, towards aligning processes and reporting templates.

As such, the biggest potential improvements in Burkina Faso's current EMIS are linked with integration, either within the education system or with other sectors. This would allow Burkina Faso's MEBA to have a more holistic view of development and the role they play in achieving broader national outcomes. Nevertheless, even just with the current state of its EMIS, Burkina Faso remains an interesting example of a country whose practices can guide other countries that are only beginning to strengthen their own EMIS.

Through UNESCO's technical support, the government of Burkina Faso was able to understand the most pressing needs and challenges faced by its education sector, and provide the necessary capacity-building that addresses those needs and challenges. UNESCO's extensive expertise and experience enables UNESCO to provide its Member States with assistance that is specifically tailored to their respective contexts. UNESCO ensures that the capacity-building it provides to Member States augments the competencies of MoE staff and improves the institutional processes needed to support EMIS, while also taking into consideration the current technological capacities of the country. Such an approach strengthens the sustainability of EMIS reinforcement.

Appendix C

OpenEMIS in the Maldives

Case Study: OpenEMIS in the Maldives

This case study is part of a UNESCO Working Paper titled "Orienting Education Management Information Systems (EMIS) towards inclusive and equitable quality education and lifelong learning".

The Government of the Republic of Maldives recognizes the importance of quality data in the pursuit of providing quality education for all. It is with this recognition that the MoE, through a partnership with UIS and UNICEF, set out to strengthen their EMIS in December 2015.

The Maldives Education Management Information System (MEMIS) started with the initial financial support UNICEF and large part of the funding came from the MoE. The education system of the Maldives sees a total of 87,295 enrolments from the pre-primary to the higher secondary levels across 247 schools, of which 211 are primary-level. The MoE collects data directly from individual schools; there are no intermediaries through which data are transmitted. This data collection process is facilitated by the fact that almost 100 per cent of schools have access to the Internet.

Implementation

The installation of MEMIS began with a thorough needs analysis that examined the current technical infrastructure of the Maldives' education sector and the quality of the educational data currently stored within its data archives. Prior to the installation of MEMIS, the MoE compiled and stored educational data through spreadsheets saved on a shared cloud drive. The central unit of the MoE would request data from individual schools, which, at the time, maintained entirely separate databases that were manually updated. Of course, having such separately maintained databases resulted in certain discrepancies in data inputting and reporting, which the needs analysis identified.

The conception and installation of MEMIS began with an evaluation of previous EMIS system by UIS in May 2014. It revealed that the MoE, at the time, still had no consistent method and schedule for data collection and analysis. Statistical analyses were done on a generally ad hoc basis. In addition, there was no established data validation mechanism multiple data collection, which resulted in discrepancies, such as the duplication of student IDs, with the same student appearing in different schools in the same year. Furthermore, since schools reported data in a manual and fragmented manner, data fields were inputted differently from one school to another. As an example, the *Student's Nationality* field saw a wide array of codes. For instance, a student of Indian nationality would be coded in different ways across different schools — for example: "Indian", or "India", or "IN" —", or it would not be reported at all. This lack of a standard for data input and reporting created difficulties in analyzing data, which caused long lead times. As such, when data were finally ready for release, they had already become outdated. The data are collected at the school level. It was not feasible to use aggregated information to track individual student attendance, achievement, behaviour, transfers and detailed teacher information, nonstandard data collection/ keeping formats used at the schools and MOE.

In June 2015, the UIS and the OpenEMIS team conducted a joint mission, with inputs from UNICEF, which focused on the technical aspects of EMIS: migration of data, development of different modules based on the requirements of the Maldives, contextualization of OpenEMIS, identification of requirements for human resource capacity-building to build the competencies needed to administer the OpenEMIS system both at the central and at the subnational levels of the MoE. These difficulties in data collection, reporting, and analysis prompted the MoE to install an EMIS software. The MOE had three main criteria in selecting an EMIS software: (1) that the software, and the data it would eventually contain, should be entirely owned by the MoE and should not operate under periodic licenses; (2) that the software could be fully configured according to the specific needs of the country; and (3) that the software should be a fully integrated EMIS with real-time data monitoring that more effectively addresses the challenges faced by the education system. Being an open-source system, OpenEMIS thus fulfills all these criteria, which led the MOE to choose the said software. The MoE invested USD 450,000 toward the installation of OpenEMIS.

Given the various inconsistencies in the data, the first step taken by the implementation team was a data cleanup. In coordination with the Department of National Registration (DNR), the MoE cross-checked data contained within the spreadsheets stored in the cloud drive and corrected erroneous data entries, such as duplicate student IDs and wrong dates of birth. Demographic information was imported from the DNR database and triangulated against MoE data for validation and reconciliation. Throughout this data validation process, the MoE and DNR also standardized data fields across spreadsheets to make sure that they could be easily imported into OpenEMIS. At the end of this five-month data validation and standardization process, the implementation team then migrated the data into MEMIS — a total of nine data sets, compiling information from individual schools across different administrative divisions

of the Maldives and spanning a period of three years, was uploaded into the system.

In December 2016, the MoE piloted MEMIS with 20 schools. The pilot schools were identified in terms of their location (urban or rural) and their respective academic level (primary school or secondary school). Once the pilot schools were identified, the MoE brought the respective principals and IT staff of each pilot school to the capital, Malé, for a week-long orientation and hands-on training on the system functionalities of MEMIS. This training session conducted in Malé trained participants both to navigate the functionalities of MEMIS, and to be able themselves to train their colleagues on using MEMIS. The participants in this week-long training session would thus become the designated MEMIS Administrators in their respective schools, ensuring that school staff not only know how to use the system, but are also *actually* using the system.

After the week-long training of trainers in Malé, MEMIS went live in the aforementioned 20 schools. At the end of a six-month pilot run, MoE staff visited each pilot school to check if MEMIS was being actively used, gather feedback on any difficulties encountered in the use of the system (or hindrances to using the system), and determine possible solutions to address those challenges. The feedback gathered from these visits was then used for the next iteration of MEMIS. The iteration incorporating the said feedback was the version that MoE launched and rolled out to all schools in July 2017.

The official launch of MEMIS in July 2017 began with another series of training sessions for school principals and IT staff, who would also become the MEMIS Administrators in their respective schools. However, to address geographical constraints, the MoE supplemented in-house training with technology-enabled training methods, such as videoconferencing and instructional videos. It must be noted, though, that the MoE rolled out MEMIS functionalities in a module-by-module manner — that is, schools were not required to input data for all MEMIS modules all at once. MEMIS Administrators were trained (and, at the time of writing, continue to be trained) module per module. These MEMIS Administrators are responsible for providing local and immediate technical support to school staff using MEMIS and for ensuring that school staff upload data into MEMIS daily. Staff from all 247 primary and secondary schools, of which 212 are public schools, received training, either in-person or remotely. It must be noted that, while most private schools in the Maldives have their own EMIS, they are nonetheless required to upload student and staff data into MEMIS for monitoring purposes of the MoE. As such, while private schools might use different EMIS software than public schools, their respective EMIS software are integrated with MEMIS.

In August 2017, the MoE formed the MEMIS Technical Team, composed of 10 full-time staff providing regular support to the school MEMIS Administrators, and troubleshooting any issues that MEMIS Administrators are unable to resolve locally. Each member of the MEMIS Technical Team is assigned a specific set of schools.

In response to limited Internet infrastructure in specific areas of the country, the MoE, in October 2017, also launched an Android/iOS student attendance monitoring application for teachers. This application could be accessed through any smartphone and designed to directly feed data into the MEMIS. The use of a mobile application allows teachers to upload real-time data despite infrastructure-related challenges and while the MoE is in the process of upgrading Internet capacities at the school level.

The current version of MEMIS being used by the Maldives MoE staff is primarily being used to facilitate recurrent classroom and school management processes, such as monitoring student and staff attendance and reporting students' academic performance. One notable current feature of the MEMIS that has already been rolled out and has proven very useful for school staff is its ability to flag absenteeism and students at risk of early school leaving. The system does this by automatically signaling students who have been absent for three consecutive days to the concerned teacher, who is then able to coordinate with the student's parents or legal guardians. If a student is absent for ten consecutive days, after the legal guardians are contacted, the system flags it to the principal who then initiates an intervention mechanism.

This same attendance monitoring mechanism has also allowed the MoE to identify out-of-school children. Once a student is flagged for absenteeism, the MoE cross-checks with the DNR to verify if the student is enrolled in any school in the Maldives — and with the Department of Migration, if necessary, to check if the student has left the country. If a student is verified to be out of school, designated MoE staff meet with the student and the student's legal guardians, and coordinate with teachers in the local school to assess the current competencies of the student and create individualized learning plans to facilitate the student's integration into the education system.

MEMIS has definitely helped the MoE in terms of school-based management processes. Beyond management and administration, however, the MoE intends to extend the use of MEMIS data for educational planning, policy formulation, and monitoring and evaluation, as they continue to steadily

roll out the different modules of the software and thus populate its database. With the capability of MEMIS to aggregate and disaggregate data at the country, zone, atoll, island, school, and student levels, MEMIS data can certainly be used for such purposes in the future, once the related functionalities are rolled out.

Best Practice Elements in Implementation

The implementation of MEMIS in the Maldives showcases a number of good practices that other countries can follow as they set out to develop and reinforce their own EMIS. At the core of MEMIS implementation success in the Maldives is the capacity development approach taken by the MoE, UIS, and UNICEF in reinforcing EMIS. The implementation team for the Maldives ensured that all MoE staff from the national level to the school level are able to independently navigate the functionalities of MEMIS. Such a capacity development approach strengthens sustainability, ensuring that ministries of education do not become dependent on external consultants for the production, analysis, and reporting of education statistics. This capacity development approach can be further broken down into two key components: (1) use of the training-of-trainers methodology; and (2) conduct of module-by-module training.

The MoE employed a training-of-trainers methodology to ensure that the competencies needed to navigate MEMIS are cascaded across the entire education system. By enabling designated MEMIS Administrators to train the staff in their respective schools themselves, the MoE strengthens institutional memory: the skills needed are not contained in a single person or unit; instead, the entire institution becomes equipped with the necessary competencies. This enhances the sustainability of MEMIS. The conduct of a module-by-module training, on the other hand, while relatively more time-consuming than a one-off training on all MEMIS functionalities, promotes complete mastery of the system. This module-by-module method is particularly notable, especially given the iterative approach that the MoE took to developing MEMIS.

Iteration is another hallmark feature of the Maldives' experience in developing their EMIS. By conducting a pilot run prior to actual launch of MEMIS, the MoE was able to gather initial feedback on the functioning of the system, identify pressure points, and make the necessary improvements in the version that was officially launched and is currently being used by MoE staff. This iterative method will also be useful for updating MEMIS functionalities in response to any future changes in the education system.

One notable feature of the MEMIS that arose from the findings of the pilot run is the use of mobile applications for live data inputting. Teachers in certain areas reported having difficulty uploading data into MEMIS on a daily basis due to weak Internet connection. An Android/iOS application was therefore created to address this issue, at least in the interim, while the government is in the process of upgrading technical infrastructure at the school level.

Of course, the quality of data contained within MEMIS is equally important as the technical and human capacities of the MoE. Recognizing this, the MoE triangulated data with the DNR, the MoE was able to eliminate erroneous information from their database, and consequently produce more accurate reports. The MoE has converted this triangulation process into a set data validation mechanism, which now allows them to identify out-of-school children and students at risk of dropping out.

The creation of the EMIS technical team is another key practice that has helped the Maldives successfully implement MEMIS across its schools. Having an institutional home for MEMIS not only helped the MoE harmonize its data, but it also created an accountability structure — making sure that there was a unit dedicated to maintaining the integrity of education statistics and that of the broader information system. The designation and training of localized support units at the school level supplements this institutional home. With MEMIS Administrators at the school level, it becomes easier for the MoE to ensure that school staff are submitting the data that the EMIS requires. In addition, these local support units are able to provide more immediate technical support to EMIS end users, thus accelerating the flow of data from schools to the central MoE office.

In sum, the MoE implemented MEMIS with a systemic approach. The implementing team examined the technology available across different levels of the education system, built the competencies of users and system administrators across the entire Ministry, and considered the existing processes in their development of their new system. Hence, different facets of the system were addressed, resulting in a successful first implementation.

Moving Forward

The primary areas for improvement in terms of strengthening MEMIS lie are the following:

- Training the MEMIS technical team on the back-end customization of the software;
- Integrating MEMIS with other government information systems;
- Extending use of MEMIS data beyond education management and administration into education planning and policy formulation, and monitoring and evaluation; and
- Enhancing capacity on identifying of relevant indicators, data reporting and use of data / indicators.

Currently, the MEMIS technical team, while completely able to navigate the full functionalities of MEMIS, are only able to make front-end changes to the system and all back-end changes are routed to the external consultants in the implementing team; that is, when there are any requested changes that require reprogramming the source code, the MEMIS Technical Team requires external assistance from computer programmers. However, the MoE has already hired computer programmers to be trained on how to modify the MEMIS source code. This will ensure that the MoE has the full capacity to both navigate *and* customize the system independently, according to their needs.

Another principal improvement that can be made is the use of MEMIS data for education planning, policy formulation, and monitoring and evaluation. Most MoE staff have still not been introduced to the more planning, policy, and monitoring and evaluation-oriented uses of MEMIS. However, as more MEMIS functionalities are introduced to staff, the MoE envisions that MEMIS data will eventually be used for educational planning and policy. In the meantime, the MoE is building its archive of historical education data as it receives inputs from different schools in the country.

Once all modules of MEMIS have been released across the entire MoE, the sensible next step would be to integrate MEMIS with other information systems being used by the Government of the Maldives. At the moment, other ministries are only able to access and extract data from MEMIS since the MoE had given them respective user accounts in the system. While this certainly allows other ministries to have access to education data, this does not allow the MoE to extract data from other ministries. As such, information system integration across the government would be a logical next step for the Government of the Maldives, as it allows all ministries to access data from other sectors, as needed, and to generate intersectoral analyses that can better inform policy development.

To prepare for system integration, the MoE could therefore begin synchronizing data formats, standards and templates with other ministries. It is also important that the MoE minimize the gaps on indicators produced by MEMIS, since these indicators are needed to monitor national education commitments. This would entail harmonization efforts at the national government level and would also be dependent on the readiness of the information systems used by other government agencies. Nevertheless, the MoE can anticipate integration by strengthening coordination with other ministries, with the purpose of aligning processes and reporting mechanisms.

In conclusion, the case of Maldives is an example of how UNESCO/UIS provides support to Member States in the field of EMIS through a holistic capacity-building approach that builds the competencies of MoE staff, considers the technological capabilities of the country, and ensures that MoEs have the necessary institutional processes in place to support EMIS. Furthermore, UNESCO/UIS anchors its support on a thorough understanding of the needs of the Member State — making sure that all support provided is based on a baseline assessment of the country's current capacities. The Maldives is thus an interesting example of a country that has managed to successfully lay the foundations for a strong, effective EMIS.

Appendix D

CapED-assisted EMIS development in Myanmar

Case Study: CapED-assisted EMIS development in Myanmar

This case study is part of a UNESCO Working Paper titled "Orienting Education Management Information Systems (EMIS) towards inclusive and equitable quality education and lifelong learning".

The Government of Myanmar considers the strengthening of its EMIS to be a critical reform requirement for its education sector. As such, the Ministry of Education (MoE) prioritized EMIS-related initiatives in its Education for All Action Plan. In a recent Comprehensive Education Sector Review (CESR), Myanmar also recognized the importance of reinforcing EMIS to improve education planning, management, and budgeting.

Myanmar aims to improve on the following education outcomes by using data collected and analyzed through EMIS:

- Access to and quality of early childhood, primary, secondary, and tertiary education;
- Efficiency of resource management and planning in educational institutions; and
- ICT, planning, and professional competencies of education administrators at the Ministry and school level.

To ensure that these objectives are systematically achieved, the MoE has developed a Five-year EMIS Strategic Plan. The MoE also solicited the technical support of UNESCO, through the Capacity Development for Education Programme (CapED; previously called CapEFA, the Capacity Development for Education for All Programme).

This case study reviews the development of Myanmar's Five-year EMIS Strategic Plan, as well as its subsequent implementation.

Challenges Encountered

The government has been collecting data on its education sector since Myanmar's independence. Education data was first recorded digitally in the mid-1980s, under the helm of the Myanmar Education Research Bureau (MERB); this was the earliest conception of EMIS in the country's education sector. In 1998, the management of education data was relegated to the Department of Education Planning and Training (DEPT). Since then, the DEPT (renamed DERPT, the Department of Education Research, Planning and Training) has been responsible for the collection, processing, and dissemination of education statistics.

Therefore, for Myanmar, it is not a question of whether or not there is a mechanism for data collection, analysis, and dissemination; clearly, there is one. It is rather a question of how effective that mechanism is.

The MoE had been operating a paper-based system to record and compile education data from various education institutions, prior to conducting its EMIS reinforcement initiatives. Data was compiled in Excel spreadsheets, updated manually on a monthly, quarterly, semi-annual, and annual basis. In other words, the MoE is able to collect and compile a substantial amount of data from the entire education sector. However, the system is inefficient, thus hindering the effective use of data for education policy and planning. These inefficiencies and shortcomings are laid out in succeeding paragraphs.

Lack of data integration and consistency. The current manual EMIS requires the completion of 15 separate forms at different intervals. Every time new data are collected, that data are entered into a new Excel spreadsheet. In addition, certain types of data (e.g. financial data) are not recorded electronically, therefore making cross-sectoral analyses difficult. Furthermore, since each data set is stored in a different spreadsheet, it is also very difficult to perform longitudinal analyses. There is also a lack of universally applied standards such as coding standards. Schools, regions and individuals are not coded consistently which makes it difficult to compare data from one year to the next.

Erroneous data reporting and limited capacity for data analysis. The lack of data integration also results in the collection of redundant data. Since data are manually aggregated by MoE staff, these data redundancies increase the likelihood of error. In addition, such redundancies limit the scope of possible analyses that can be performed using the data. The same can be said for school financial data, which take a large amount of time and effort to record. This is made even more difficult by the lack of data validation mechanisms in the MoE's existing EMIS. While data produced at the national level were found to be reasonably consistent, sub-national data are more inconsistent. Since the MoE already has only a limited range of statistical tools at its disposal, erroneous reporting further prevents the conversion of available data into information that is readily understandable and usable for education policy and planning. From a financial standpoint, this prevents the

MoE from analyzing long-term expenditure patterns and from identifying over- and underspending schools.

Given these challenges, there have been efforts to automate and improve the manual system. In 2009, the Ministry partnered with UNICEF to develop a Township Education Management Information System (TEMIS). The TEMIS was piloted in eight townships. However, this pilot was discarded in 2011. TEMIS faced several challenges which needed to be taken into account in the expansion of a sector-wide web-based EMIS:

- **Non-integration with HRIS.** The MoE uses a HRIS software to digitally manage some of its personnel data. However, TEMIS did not integrate with the HRIS software. In addition, this HRIS only contains high-level staff qualifications and does not conclude the full pre-service qualification list. The software's data merger module is also still non-functional, resulting in possible data alignment issues between national and sub-national databases.
- **Unsynchronized data entry.** Data entry has run parallel across different townships. In addition, there is no uniform application of data standards, resulting in inconsistently coded school data.
- **Lack of report generation capacity.** Report generation was mostly done manually and thus, very labor-intensive. The tediousness of report generation, in consequence, prevented regular production and dissemination of education statistics.
- **Lack of documentation on previous management information system (MIS) installations.** There is limited information available about the implementation of MIS. As such, there are no existing references pertaining to previous needs and requirements analyses, system design, and annual maintenance reviews.
- **Weak ICT infrastructure.** Myanmar still does not have full sustainable technical support model for its ICT infrastructure. In addition, there is no report available on the percentage of schools (by region) with readily available computers and internet access. It can be assumed, however, that the percentage is likely to be low, and that most small schools have limited access to computers.
- **Lack of an overall approach to Information Management.** The TEMIS was developed as a stand-alone system for one subsector, the basic education subsector. Consideration was not given to information systems, standards and processes used throughout the Ministry.

As such, UNESCO set out an implementation strategy that addresses all these aforementioned issues. This implementation strategy is discussed in the succeeding section.

Implementation Strategy

UNESCO's CapED implementation strategy places great emphasis on the following elements:

- Building the competencies of MoE personnel;
- Improving hardware;
- Improving access to education data through a unified EMIS software system;
- Improving data quality; and
- Enforcing data-driven school planning.
- Supporting a single system, integrated and decentralized approach employing common data standards and processes.

This section will discuss each of these elements in detail, identifying best practice elements where they are present.

It is important to note that Myanmar's MoE formed a team that is especially dedicated to its EMIS reinforcement project: the EMIS Implementation Unit (EIU). This team is composed of twelve members exclusively working to ensure the smooth implementation of the EMIS strengthening initiative. The formation of a dedicated counterpart team from the MoE is in itself a good practice that other governments looking to implement similar projects can emulate.

Strengthening competencies. The CapED team recognizes that the knowledge and skills of MoE staff is the foundation of an effective EMIS. As such, the team incorporated human resource development as one of the primary thrusts of its intervention. UNESCO's approach to capacity-building is two-pronged; the team focused on (1) recruiting skilled and qualified staff at the regional level and (2) training staff members who are involved in EMIS administration.

The availability of qualified staff at the regional level becomes a critical success factor in strengthening Myanmar's EMIS, given Myanmar's move toward the decentralization of data collection, data analysis, and school planning. At the time of writing, Townships only have two dedicated data management staff, most of whom have not been trained in education planning.

This is inadequate vis-à-vis the envisioned decentralization of data reporting, data analysis, and school planning. As systems evolve, so will the roles of data management staff. Lower-level administrative staff will be expected to enter and report progressively more data at decentralized offices while higher-level staff will be expected to perform more data analysis, provide support to educational planning, and help determine priorities of the schools in their respective areas of responsibility. Therefore, new staff who have the required competencies will be recruited to augment the MoE's data management capability. On the other hand, existing staff will be trained in school planning to help them adjust to their enlarged roles. To ensure follow-through, the Ministry has already allocated a budget solely for recruiting and training personnel.

Improving hardware. Since Myanmar's EMIS reinforcement project involves system automation across all levels of the education sector, it is critical to understand the existing technological infrastructure both in the central office and on the ground. Recognizing this, UNESCO and Myanmar's MoE conducted a hardware and Internet assessment prior to developing the EMIS software. The EIU administered a survey of all offices and a sample of 400 schools in the Myanmar public education system to identify any technological gaps that need to be addressed. The 400 schools were chosen through a stratified random sampling based on the following criteria: (a) district; (b) level of education offered (primary, middle, or high school); and (c) location (urban, rural, or remote).

The results of this assessment were used not only to assess the feasibility of deploying an online EMIS, but also to estimate the budget that would be required to bridge gaps in infrastructure. The team has in fact already detailed the necessary hardware purchases and their corresponding cost implications. UNESCO and Myanmar also considered the possibility of activating mobile-friendly functionality for capturing EMIS data. To help the Myanmar MoE fund the upgrading of its hardware, UNESCO and the EIU approached both public and private partners. However, to ensure the MoE's commitment, they also required a counterpart budget from the Ministry. In addition, UNESCO and the EIU put in place a bi-annual review to ensure correct budgeting and efficient spending.

In recognition of the fact that internet access will continue to be limited in many schools for the foreseeable future, both online and offline reporting mechanisms were put in place. This will ensure EMIS reporting can also take place in areas with no current internet connectivity.

Improving access to education data through a unified EMIS software system. As a first step to installing EMIS software, UNESCO and the EIU team mapped out the reporting and data requirements of the MoE for education planning, monitoring, and evaluating basic education. To facilitate data use, the team standardized report formats and developed training materials on how to interpret those reports. This involved looking at the various existing manual forms and making them more uniform.

An initial but fully functional version of the EMIS software is being piloted in three Township Education Offices (TEO) to ensure that the system is functioning as intended. This pilot is testing the first two modules developed as part of EMIS Phase 1, the Basic Education and Human Resources modules. The pilot will be completed in April 2018, after which EMIS software for these two modules will be rolled out nationwide in May 2018. As part of the rollout, involved staff will undergo technical training in operation, backup, maintenance, and restoration of the new software. These training sessions shall be accompanied by monthly staff mentoring sessions across all offices of the MoE.

As part of EMIS Phase 2 software for three additional modules are currently being developed. These are the Higher Education and TVET module, the Non-Formal Education module and the Finance, Assets and Procurement Modules. The rollout of Phase 2 will follow the same stringent piloting and testing procedures as Phase 1. Once fully rolled out, UNESCO and the EIU team shall perform a regular review of the EMIS software to make sure that it continues to meet operational and planning requirements.

Improving data quality. A data management software is only as good as the data it contains. As such, UNESCO and the EIU intend to put in place measures that will ensure data quality and integrity. Together with representatives across different levels of the Ministry, UNESCO and the EIU team shall develop thoroughly defined education indicators and shall determine which of these indicators are required for which education monitoring reports. The team will then create a handbook for school heads and staff that details definitions for all educational statistics and indicators. This handbook aims to strengthen institutional memory, in effect promoting the sustainability of the system.

UNESCO and the EIU team has rationalized existing data collection and reporting forms, with the aim of preventing the collection of redundant or superfluous data. Furthermore, the team will be establishing a regular data collection schedule, thus systematizing what used to be an intermittent process. School EMIS codes have been standardized and future policies will ensure the inclusion of data from private and religious schools under EMIS.

The implementation team will also put in place validation mechanisms to ascertain that only accurate and reliable data are housed within the information management system. For instance, UNESCO is considering the role that NGOs and development partners may play to serve as third-party data validators. The MoE's planning department shall also be trained to triangulate education data with other data sources, such as census and household data. In addition, UNESCO and the EIU intend to establish a policy that links the approval of school discretionary funding to the provision of credible school data, thus incentivizing data accuracy.

Enforcing data-driven school planning. With all the requisites for efficient and reliable data collection, reporting, and analysis, the next step would be to make sure that data are used in determining sector and school priorities and identifying the corresponding action steps to fulfil those priorities.

To do this, UNESCO and the EIU team intend to develop and pilot a training programme for education managers that would enable them to generate and interpret reports through the EMIS software system. Feedback from this pilot will inform succeeding iterations of the training modules for education planners across all levels of the Ministry. UNESCO will also incorporate data analysis and evidence-based decision making into the Programme Development Module of the National Education Management and Training Centre, again for the purpose of reinforcing institutional memory.

UNESCO's CapED Programme recognizes that EMIS reinforcement projects will only be successful and sustainable if they are systemic — that is, if they address not only the technological aspects of EMIS, but also material, financial, human, and institutional factors. UNESCO's method for strengthening EMIS can be considered a good practice in that it is anchored on a holistic capacity-building approach.

Supporting a single system, integrated and decentralized approach employing common data standards and processes. UNESCO and the MoE took the approach of developing an integrated system rather than a series of discrete and isolated modules. Thus, all subsectors draw data from a common database. This ensures application of common standards and processes throughout and enables the sharing of the human resources and student tracking information throughout. This way, a student can have their academic record traced throughout the education cycle.

This also helps Myanmar avoid the situation that exists in many other countries where ministries operate many standalone and isolated systems, each owned by a different department. Having an integrated and shared system allows all stakeholders to access information on a needs basis rather than having to request information in different formats and with differing data standards from separate departments. In addition, it helps reduce the costs of information capture and management and increases information-sharing.

UNESCO's CapED Programme recognizes that EMIS reinforcement projects will only be successful and sustainable if they are systemic — that is, they address not only the technological aspects of EMIS, but also its material, financial, human, and institutional factors. In sum, UNESCO's method for strengthening EMIS can be considered a good practice in that it is anchored on a holistic capacity-building approach.

UNESCO
United Nations Educational, Scientific and Cultural Organization
Education Sector

Re-orienting Education Management Information Systems (EMIS) towards inclusive and equitable quality education and lifelong learning

This Working Paper provides conceptual frameworks and strategies to help countries reorient their Education Management Information Systems (EMIS) to support inclusive and equitable quality education and lifelong learning opportunities for all, in line with Sustainable Development Goal 4 (SDG 4). It emphasizes the potential of EMIS to support the implementation of SDG 4 at the national, state, local and classroom levels.

The paper first outlines how new international priorities for education — especially the focus on learning outcomes and learning across life in formal, non-formal and informal contexts — have placed new demands on EMIS. It posits that, going forward, EMIS should collect an expanded range of actionable data to both improve teaching and learning and provide insights into how education can be linked with different sectors to advance a wider range of development objectives.

The paper recommends that countries work to strengthen EMIS in at least four functional domains: management and administration; planning; policy formulation; and monitoring and evaluation.

After establishing the need for robust data systems to support progress toward SDG 4 and the wider 2030 Agenda for Sustainable Development, the paper looks specifically at strategies to build technical tools; human resource capacities; and policies, plans, and institutional arrangements to support the development of EMIS.

Case studies provide practical illustrations of how UNESCO is working with its Member States to reinforce data gathering capacities and leverage existing systems to inform and steer education reform.

Finally, the paper reflects on future directions for EMIS, drawing attention to opportunities and challenges likely to emerge in the decade ahead.

4 QUALITY EDUCATION
Sustainable Development Goals