GUIDANCE ON IMPLEMENTATION OF THE NATIONAL SMART EDUCATION FRAMEWORK
Guidance on Implementation of the National Smart Education Framework
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EXECUTIVE SUMMARY

The COVID-19 pandemic has brought unprecedented challenges to education. However, it has also given us renewed hope and more reasons to work on strategic solutions for how to reshape education to adapt to our uncertain, complex and diverse world.

The development of this framework and guidance for smart education could make it possible to do just that by fostering human and social development worldwide through the rethinking and redesigning of national smart education strategies. This will be done by elaborating on the most up-to-date and adequate policy agendas which would likewise expand access to quality education and relevant lifelong learning opportunities for all.

This guidance will focus on how smart education should be implemented at the national level by using the National Smart Education Framework. The National Smart Education Framework consists of three leverage points: 1). a renewed focus on transformative teaching and technology-enabled learning, 2). building a digital learning infrastructure conducive to smart education and 3). Ensuring forward-looking governance and policy initiatives. To implement these leverage points three factors must be considered: 1). Inclusion and equity, 2). continuous improvement culture and 3). multi-sector cooperation and partnerships.

First, this guidance introduces the concepts and theories of smart education to provide a theoretical basis for the construction of the National Smart Education Framework.

Then, the framework for building smart education at the national level is elaborated on to ensure a flexible modern smart education eco-system, that is sustainable and meets the needs of all stakeholders.

Finally, how the smart education framework should be implemented at the national level will be explained from four aspects and twelve indicators. The 4 aspects are 1). transformative teaching and learning enabled through technology, 2). a digital learning environment conducive to smart education, 3). Forward thinking governance and policy initiatives and 4). overall consideration across all leverage points. The 12 indicators are 1). student-centered pedagogy, 2). reimagined assessments, 3). learners’ community-building, 4). learning devices and support, 5). seamless connectivity, 6). ethical use of technology, 7). developing a national vision and plan, 8). building infrastructure capacity, 9). investing in human capacity, 10). inclusion and equity, 11). a continuous improvement culture and 12). multi-sector cooperation and partnerships. Each indicator will be discussed according to three logical structures: 1). why it is important, 2). how to implement it and finally 3). recommended relevant materials are given for the reader’s reference (mainly for teachers, students and/or parents to make the stated recommendations more generally applicable).

Utilizing the goal of UNESCO’s SDG4 which states that all countries should “ensure inclusive and equitable quality education and promote lifelong learning opportunities for all”, this guide has three overarching intentions: 1). provide a reference for making smart education policies at the national level, 2). promote international cooperation in smart education and 3). boost the achievement of the SDG4 goal, while also developing educational quality and facilitating educational equity.
The COVID-19 pandemic has brought unprecedented challenges to education. In this special situation, lots of students have had to learn online, which tests the resilience of ICT in education all over the world. Individuals and communities should be prepared to rethink and reshape the future of education. Strategic solutions on how to reshape education are needed to be worked out to adapt to an uncertain, complex and diverse world.

The development of the framework and guidance for smart education could make it possible to foster human and social development worldwide through the rethinking and redesigning of national smart education strategies and elaborating on the most up-to-date and adequate policy agendas to expand access to quality education and relevant lifelong learning opportunities for all.

Smart education can a). help ensure that all learners acquire the knowledge, skills and expertise needed to promote sustainable development, b). provide safe, inclusive and effective learning environments for all groups of learners, c). play an important role in the transformation of national education systems in various countries and d). significantly contribute to achieving the SDG4 goal.

This guidance will be of benefit following stakeholders:

- Government policymakers at the national, regional or local level who develop smart education policies and strategies and governmental agencies who will implement them.
- Researchers who are interested in ICT in education or smart education.
- Practitioners who are implementing education supported by emerging technologies.

We acknowledge that there are many other stakeholders in the smart education policy and implementation ecosystem, including the United Nations organizations, civil society organizations and academia. These stakeholders can also draw useful information from this guide.
In this age of intelligence, digital pedagogy that is informed by the learning sciences, that considers life-long and life-wide learning is essential for learning outcomes. A new generation of information technology, such as artificial intelligence, can be an effective means to realize the ecological remodeling of education. Ensuring the balance and quality of education and moving towards intelligent education is the ultimate goal of technology to reshape the future of education (Huang et al., 2021).

1.1. Three Realms of Smart Education

Smart education (system) (as shown in Figure 1.) is considered as the educational behaviors (system) provided by schools, regions or governments with the characteristics of a high learning experience, learning content adaptation and teaching efficiency. Modern science and technologies are used to provide diversified support and on-demand services for students, teachers and parents, etc. The data of participants and learning and teaching processes are recorded and used to promote the quality and equity of education.

The essential features of smart education are sensibility towards the learning environment, adaptability of learning content to learners, respect and carefulness from educators towards learning groups and the orchestration of different elements within the education system.

Firstly, sensibility toward the learning environment and the adaptability of learning content to learners are the key features of smart learning environments, with which the education system makes people experience SMARTNESS.
Secondly, the personality and diversity of students will be respected under the innovative learning modes, which will help students learn in an easy, engaging and effective way. The core objective is to help to enlighten students’ wisdom.

Finally, with the support of big data, we can analyze and simulate the schools’ setting in one area education finance, employment channels, students’ selection and other subsystems of the education system and the development of their relationships among those subsystems in advance. This kind of information provides evidence for reformation and decision-making in the teaching system, school administration system and even the education system at the provincial and national levels. The analysis and simulation with big data can help to innovate the talent cultivation system and promote educational equity across urban and rural regions and schools. All of which aim to develop a modern education system that supports the development of human wisdom (Huang, 2014).

1.2. Smart Learning Environments

Smart learning environments should have the following characteristics:

- Smart learning environments should integrate physical environments and virtual environments. In the smart learning environment, the perceptive, monitoring and regulating functions of the physical environment are further enhanced. The application of the technology of augmented reality creates the seamless integration of the virtual environment and physical environment.

- Smart learning environments should provide better learning support and services according to the individual characteristics of learners. Smart learning environments emphasize the process record, personalized assessment and evaluation of effects and content delivery of the learner’s learning. According to the learner model, it plays a significant role in planning, monitoring and evaluating the development of a learner's learning capabilities.

[Diagram: The System Model of Smart Learning Environments]
Smart learning environments support in-campus learning and off-campus learning, formal learning and informal learning. The learners in this situation are not only the campus learners but also all people that have requirements of learning in their work as well as personal learning goals.

Therefore, we regard smart learning environments as the learning place or an activity space that can be aware of learning scenarios while also identifying the characteristics of learners, providing appropriate learning resources and convenient interaction tools, automatically recording the learning process and evaluating learning outcomes in order to promote the effective learning of the learners (Huang et al., 2012).

Smart learning environments mainly consist of the six elements of learning resources, namely intelligent tools, learning community, teaching community, learning ways and teaching ways, as shown in Figure 2.

The smart learning environment is mainly composed of learning resources, intelligent tools, learning communities, teaching communities, learning and teaching methods.

Learners and teachers interrelate and interact with the other four elements by learning and teaching methods, to promote the occurrence of effective learning by the learners. Without learning and teaching methods, the smart learning environment is not a learning loop.

The occurrence of effective learning is the result of a combination between an individual and a group construction. Learning communities emphasize the interaction, collaboration and communication of learners. Likewise, a teaching community is a unity in which teachers learn together, work collaboratively and seek continuous professional development.

Learning resources and intelligent tools provide support for both the learning community and the teaching community. The development of the learning community and the teaching community is inseparable from the mutual effects of resources and tools. All kinds of intelligent tools provide comprehensive support for the “intelligence” of the learning environments. At the same time, the learning community and the teaching community advance the evolution of resources and tools.

The technical features of smart learning environments are mainly reflected in the five aspects: tracking, recognizing, connecting and awareness, with the aim to promote easy, engaged and effective learning of learners.

Tracking learning process. Smart Learning Environments (SLE) can be aware of and track the status of learners in the aspects of knowledge acquisition, classroom interaction, group collaboration, etc. By using technologies of motion capture, emotion computing and eye movement, SLE can track the learning process, analyze learning outcomes and establish the learner model, which provides an important basis for providing a more comprehensive and accurate assessment of the learning effects of the learners.

Recognizing learning scenarios. Smart learning environments can provide personalized resources and tools for learners according to the learner model and learning scenarios to facilitate the occurrence of effective learning. It can recognize learning scenarios including learning time, learning place, learning peers and learning activities. The recognition of learning scenarios provides support for teaching activities.

Awareness of the physical environment. Smart learning environments can monitor air, temperature, light, sound, smell and other physical environmental factors with sensor technology to provide learners with a comfortable physical environment.
● Connecting learning communities. Smart learning environments can set up a learning community for specific learning scenarios and provide support for the learners for their effective connecting and using of the learning community for communication and exchange.

● Easy, engaged and effective learning. The objective of smart learning environments is to create the tracking, recognizing, awareness and connecting conditions for learning to promote easy, engaged and effective learning for all learners.

Documenting processes, identifying scenarios, sensing the environment and connecting communities to facilitate easy, committed and effective learning for learners not only reflects the technical characteristics of the smart learning environment but also its functional requirements which can be regarded simply as TRACE3 smart learning environment functional model (Huang et al., 2012). This is shown in Figure 3.

### 1.3. Smart Learning

As a type of learning system, smart learning can perceive learning environments comprehensively and recognize learners’ characters, provide suitable learning resources and convenient interactive tools, track learning progress automatically and assess learning outcomes with the support of the Internet of Things (IoT), big data systems, artificial intelligence techniques and other modern high technologies. Likewise, smart learning can support learners’ lifelong learning, career development and self-actualization effectively.

In a smart learning environment, a learner can learn at anytime, anywhere, in any way and at any pace, which is short for “4A”. Such an environment is capable of supporting “Easy Learning”, “Engaged Learning” and “Effective Learning” which is short for “3E”. In a smart learning environment, the easy, engaged and effective learning could be regarded as smart learning (Liu et al., 2017), as shown in Figure 4.

![Figure 3 TRACE3 Functional Model of the Smart Learning Environment](image-url)
learning (3E) at anytime, anywhere, in any way and at any pace (4A) could be regarded as smart learning (Liu et al., 2017). This can be seen in Figure 4.

Smart learning has three basic characteristics:

- First is Easy Learning, which is the prerequisite for engaged learning; smart instruction makes the learning process become more engaging and inclusive.
- Second, Engaged Learning is the precondition for effective learning; only through engaged learning are students able to communicate and have good cooperation with their fellow students and thus achieve the designed learning objectives.
- Third, Effective Learning is the target of smart learning, which means smart learning shall bring the desired learning results effectively.

![Figure 4 Characteristics of Smart Learning](image-url)
CHAPTER 2.

FRAMEWORK FOR BUILDING SMART EDUCATION AT COUNTRY LEVEL

Based on the experience during COVID-19, to achieve the Education Agenda 2030, it is a common understanding that national government leaders should engage in a multi-pronged approach with three major leverage points to promote smart education: 1) a renewed focus on transformative teaching and learning enabled through technologies, 2) building a digital learning infrastructure and 3) ensuring forward-thinking governance and policy initiatives.

Based on the case studies of smart education in different countries, the framework of smart education (as shown in Figure 5.) is proposed within the three layers: municipal level, regional level and national level. On the other dimension, three leveraging points of smart education should all be contextualized at each layer including transforming teaching and learning, digital learning environment and forward-thinking governance.

Government leaders should place several overarching considerations at the forefront to ensure that the modernized smart education ecosystem is agile, sustainable and meets the needs of all stakeholders.

Figure 5 The National Framework of Smart Education
This framework focuses on students, teachers and parents and further considers smart education from three layers: municipal, regional and national.

1). An important part of this framework is transformative teaching and learning enabled through technology. This fundamental shift necessitates an in-depth look by stakeholders on how to improve pedagogy, assessments and learner communities. Below are some recommendations:

- Student-centered pedagogy: appropriate use of technology provides students with multiple pathways for authentic learning beyond the physical classroom including, but not limited to personalized learning, collaborative learning, design-based learning and project- or problem-based learning.
- Reimagined Assessments: assessments are embedded as part of the learning process and encompass the full range of their purpose and function including, but not limited to assessment of learning, assessment for learning and assessment as learning.
- Learner Community-Building: technology helps students grow as civic-minded members of their local and global communities. Skills and competencies that can be developed and reinforced include, but are not limited to social-emotional skills and digital citizenship competencies.

2). In addition, modernized digital learning environments which allow for learning to occur anytime and anywhere are required. Some recommendations include:

- Learning Devices and Support: digital learning devices conducive to smart education so as to help solve and/or troubleshoot technical issues.
- Seamless Connectivity: all students and educators must be supported in becoming

- Ethical Use of Technology: personal and performance data must be safeguarded from misuse. Considerations may include but are not limited to data privacy, interoperability and ethics of artificial intelligence (AI).

3). To develop a national vision and plan for the effective use of educational technology, forward-thinking governance and policy initiatives are required. Below are some recommendations:

- Develop a National Vision and Plan: a shared vision is needed to establish the essential role that technology plays in ensuring students’ future success and its implications for improving a nation’s equitable social and economic conditions.
- Build Infrastructure Capacity: advanced telecommunications and information services ensure that all communities are connected to high-speed internet.
- Invest in Human Capacity: modernizing the educator workforce includes government leaders funding educators’ preparation, professional development, coaching and mentoring opportunities.

4). Last but not least, in this framework, government leaders must place the following overarching considerations across all leverage points at the forefront.

- Inclusion and Equity: policies and approaches ensure the full participation and inclusion of people.
- Continuous Improvement Culture: educators and leaders collaborate with stakeholders to continuously support the broader vision around technology-empowered learning.
- Multi-Sector Cooperation and Partnerships: government leaders leverage influential sectors, institutions and organizations to promote transformative uses of technology for learning.
CHAPTER 3.

RECOMMENDATIONS ON IMPLEMENTING
THE NATIONAL SMART EDUCATION FRAMEWORK

3.1. Transformative Teaching and Learning Enabled through Technology

A modernized digital learning ecosystem requires a renewed, shared understanding among leaders and stakeholders around what an effective educational experience transformed through technology should look like (Tri et al., 2021). For example, how does technology empower educators and students to co-develop experiences that move from traditional, drill-and-skill instruction to models where the learner is no longer just the passive recipient of information? This fundamental shift necessitates an in-depth look into improving pedagogy, assessments and learner communities.

In order to utilize technology to promote the transformation of teaching and learning, the following principles could be considered:

- Maintaining student-oriented: 1). leverage the new generation of technologies to embrace online merging offline (OMO) methods and innovate the educational ideas, contents, methods and approaches, 2). build a suitable technology-enhanced learning environment for student development, 3). cultivate students’ awareness and habits of independent study and 4). pay attention to differentiated teaching and individual guidance and promote personalized learning.

- Emphasizing classroom reform: 1). pay attention to developing students’ digital learning and innovation ability, 2). create classrooms that meet students’ cognition, inspire interest in learning, support knowledge construction processes and promote the development of thinking and 3). enrich teaching content, break through classroom boundaries, expand teaching space-time, strive to explore interactive, inquiry-based teaching (Huang et al., 2010), experiential teaching and lastly, carry out research-based, project-based and collaborative learning.

- Strengthening practical study: 1). actively establish a mechanism that can mobilize teachers’ enthusiasm in the informatization of teaching, digital resources construction and so on, 2). take the initiative to pay attention to the feedback of teachers and students in the process of information technology application and 3). promote students’ learning positivity and initiative (MOE, 2021).

3.1.1 Student-Centered Pedagogy

The Importance of Student-Centered Pedagogy

There is a necessary paradigm shift in education from issues of accessing and sharing information to designing active and collaborative learning environments where participants are actively engaged in deep and meaningful learning (Vaughan, 2013). Meaning the focus of pedagogy has shifted from teacher-centered to student-centered.
Student-centered learning moves students from passive receivers of information to active participants in their own discovery process. What students learn, how they learn it and how their learning is assessed are all driven by each individual student’s needs and abilities. Learning differences should be valued among students, and a student-centered, data-driven approach should be applied to identify learning differences for all students (ISTE, n.d.).

Student-Centered Pedagogy has many benefits. For example, personalization improves students’ attitudes towards learning; service and project-based learning increases student engagement; and teaching students how to self-regulate improves academic performance (NCSL, 2022).

So, the development of student-centered pedagogy is very essential as the availability of technology may expand the potential of student-centered learning (NMEF, 2016).

**Implementation Guidance**

Information technology has expanded learning spaces to physical merging virtual spaces, provided intelligent learning tools and offered abundant learning resources, all of which are the basis to reshape teaching and learning. ICT plays a key role to realize the innovation of learning models in spaces, teaching methods, learning content and learning approaches.

In terms of learning space, with the support of the internet, the original physical learning space has been expanded to both virtual and physical spaces. Furthermore, new teaching models of Cyber Delivery Classrooms, Cyber Learning Spaces and Synchronous Remote Twinning Classes have been created to promote education in rural and remote areas for equity.

In terms of teaching methods, ICT provides new opportunities for teachers to carry out instruction in a more flexible way, for example, Flipped Classrooms emerged as important methods.

In terms of learning content, more and more online learning resources promote students’ self-directed learning. Design-based Learning has become an important learning method based on learning content.

In terms of learning methods, students can establish collaborative relationships with learning peers or teachers, carry out seminars and exchanges and cooperate in projects utilizing AI. Such examples have made the Guided Mobiles Discovery Learning with, Collaborative Knowledge Building and Competency-based Learning popular.

These models all have innovative teaching ideals, that allow teachers to think deeply about teaching practice problems and form relatively stable operating procedures. There are numerous cases both at home and abroad that can be used as evidence, and furthermore, the models have produced significant effects in teaching practice.

1) **Cyber Delivery Classroom** (The Education Plaza of Zhi jiang hui, 2020)

This model can help students in remote areas and other such schools enjoy high-quality teacher resources and achieve balanced development of education. The procedures mainly include:

- Selecting outstanding teachers: teachers are required to prepare relevant courses and clarify the forms and objectives of teaching.
- Using network technology to carry out teaching activities: require real-time "Delivery Classroom" at weak schools, record the teaching process in advance and distribute it in the form of digital CDs to other weak schools.
2) Cyber Learning Spaces (The Education Plaza of Zhi jiang hui, 2019)

By using CLS, teachers can build a positive classroom community, implement effective communication strategies and facilitate collaboration between teachers and students in a blended or online learning environment (ISTE, 2018). The operating procedures include:

- Preparing teaching materials: including registering Cyber Learning Spaces, reorganizing massive resources, designing teaching and forming digital teaching plans.
- Organizing learning: teacher sends the learning plan to the student space before class and organizes the students to use the learning space to carry out self-learning (Huang et al., 2010) and inquiry-based learning.
- Interacting Q&A: including student appointments, teacher tutoring and Q&A.

3) Synchronous Remote Twinning Classes (Shao Xing Shu Ren Primary School., 2021; Sohu, 2016)

The Synchronous Remote Twinning Classes are mainly based on internet live streaming broadcasting. Synchronous teaching activities are carried out between two classes with equal teaching conditions and complementary teaching advantages in order to achieve "concept sharing, resource sharing, complementary advantages, and cooperation and progress" between schools and classes. The procedures mainly include:

- Infrastructure constructing: configuring computers, webcasting systems, cameras, microphones, loudspeaker and other basic equipment.
- Working together to develop a plan: teachers from both sides work together to prepare lessons and achieve consISEnent teaching content. The teachers should also work together to connect both sides through the live broadcast system and realize voice and video interaction.
- Summarizing and exchanging experience: the two classes should deepen the effect of cooperation, enhance the tacit understanding of cooperation and promote the teaching effect.

4) Flipped Classroom (University of Cambridge, 2020)

The flipped classroom has flipped the traditional teaching process. Thus, in such a classroom students could watch micro lectures before class and do exercises or PBL in class. The operating procedures include:

- Before class: teachers should design teaching content suitable for students’ self-learning; students complete targeted tasks in advance and have interactive communication with teachers and classmates.
- In class: teachers should design classroom activities using instructional tools such as choice boards, checklists and playlists to activate students’ autonomy in the classroom and improve engagement, motivation and work completion through intentional lesson design and delivery (ISTE); teachers should give more targeted guidance according to the problems found in the interaction between teachers and students.
- After class: students deal with the learning content and grasp the learning progress and style; teachers adopt guidance and collaboration to meet students’ learning needs.
5) Design-based Learning (The Center for City Building Educational, n.d.)

As an important part of maker education, this teaching model is conducive to improving students' innovation and design ability, and experiencing and optimizing the teaching process of STEAM education. The operating procedures are:

- Conceptualization: learners accept the teacher's challenge, clarify the tasks of the project and further clarify the goals and tasks of the project through brainstorming to formulate ideas and possible solutions.
- Creating and testing: first, learners choose a feasible method to design, create and form models; second, learners show their phased products to others, redesign and modify according to others' suggestions and demonstrations; finally, re-testing, learners continuously find and modify the technology and methods to achieve their product.
- Knowledge acquisition: comprehensively and systematically record students' learning situation, self-evaluation, teacher evaluation and so on.

6) Guided Mobilized Discovery Learning

This model of teaching not only is for students to explore learning content in the classroom through mobile devices but also to carry out inquiry-based learning in informal learning situations such as Museums, Science and Technology Museums, Ecoparks, etc. The operating procedures are:

- Clarifying the theme of inquiring: developing mobile-based digital teaching resources.
- Detailed learning tasks: identify appropriate learning tasks for each learning group.
- Matching learning resources: using learning resources to organize inquiry-based learning and discussion.

- Guiding students to reflect: teachers should comment on the results of students' discussions and form evaluative reflections.

7) Collaborative Knowledge Building (Gilbert & Driscoll, 2002)

As a typical form of group cooperative learning, this teaching model generates new knowledge through exchange and dialogue between teachers and students or students and students, which can promote the cultivation of a high-level cognitive ability. The operating procedures are:

- Student grouping: reasonable collocation and divided into study groups.
- Setting goals: teachers and students work together to set training goals for each lesson.
- Instructional approach: providing students with a bridge of transition from the known to the unknown.
- Group collaboration: when carrying out learning, the teacher needs to provide the necessary guidance and regulation.
- Commenting summary: the teacher guides students to reflect after the results of the group are presented.

8) Competency-based Learning (Prodigy, 2021)

The fundamental purpose of competency-based learning is to cultivate the core competencies of students.

- First, teachers should set evaluation standards in such learning content, which includes measurable, skillful or clear learning objectives. As these will allow students to self-regulate learning in various ways.
- Second, students who meet the standards should be recognized as qualified, and then move to the next phase of content.
These procedures mainly include: problem-driven, discovery ideas, exploratory experiences, result sharing and comprehensive applications (Smart Learning Institute of Beijing Normal University, 2020).

**Recommended Materials**

Technology can be used to amplify and even transform learning and teaching. There are many pedagogies that could be used in any given classroom. For example, blended learning refers to situations where students receive instruction in both face-to-face and online environments (ISTE, 2016). Flipped learning — the name says it all. It’s a 180-degree shift in how we approach learning and teaching (ISTE, 2014). Jon Bergmann and Aaron Sams, co-authors of Flip Your Classroom (Bergmann & Sams, 2012) and instigators of the flipped revolution, encourage teachers to keep the following in mind as they embark upon their journey towards flipped learning: Flipping is a messy process; it is a game changer for students — and some will hate it; you will work hard; your students will work even harder; and you will become even more irreplaceable.

In addition, we can develop a student-centered classroom (EducationCorner.com, n.d.) by turning the classroom into a community, developing trust and communication, finding ways to integrate technology, creating an environment where mutual respect and a quest for knowledge guide behavior—not rules, replacing homework with engaging project-based learning activities and so on.

As the COVID-19 coronavirus continues to spread, schools around the globe are shifting to online learning (ISTE, 2017) in an effort to slow the spread of the disease. Thus, we must ask ourselves, how can we make online learning better?

First, there are 10 strategies for online learning during a coronavirus outbreak (ISTE, 2020): ensuring digital equity, practicing, providing clear expectations to staff and parents, taking time to plan, packing your bag, establishing daily schedules, providing robust learning, designing independent learning, addressing the emotional toll and choosing the right tools and sticking with them.

Second, there are 10 tips for success in online classes (ISTE, 2020): establishing a productive learning environment, setting a schedule for completing and reviewing assignments, seeking virtual interactions with your peers, using the ‘chunking’ strategy to section out tasks, trying to increase your interest in the work, making the work you are doing online more personally significant, imaging yourself on a path toward mastering the subject, problem-solving on your own, focusing on your self-care and having compassion for others.

Third, there are 4 ways to support educator professional development during remote learning (ISTE, 2020): developing easy-to-follow technology training, providing virtual communication best practices, creating and curating digital content specific to the remote classroom and not forgetting about self-care and student social emotional health.

Finally, there are 7 ways to make remote learning accessible to all students (ISTE, 2020): multiple means of representation, multiple means of engagement, multiple means of action and expression, using open educational resources (OER), designing for accessibility, staying connected with your students and connecting with other educators.
3.1.2 Reimagined Assessments

The Importance of Reimagined Assessments

Assessment is an integral part of instruction, as it determines whether or not the goals of education are being met. Assessment affects decisions about grades, placement, advancement, instructional needs, curriculum and in some cases, funding (George Lucas Educational Foundation, 2008). Assessments help learners and adults identify progress and challenges and tailor strategies and pathways towards mastery. Assessments are embedded in the learning experience and provide opportunities to demonstrate mastery through performance-based tasks and real-world settings (Education Reimagined, 2016).

Facing a new round of technological revolution and industrial change, the assessment paradigm needs to be changed. The previous blind focus on summative assessment should be changed to the formative evaluation and multiple evaluations supported by digital technology. Technology has the potential to move assessment from disjointed separate measures of student progress to an integrated system of assessments and personalized instruction to meet the needs of each learner. Technology can integrate more fully student classroom experiences, homework assignments and formative and summative assessments, all of which are tied closely to academic standards. Online learning platforms can display the effects of missing assignments, progress toward goals and create channels for communication with mentors and teachers (Office of Educational Technology, 2017).

Now, there are three orientations for assessment: assessment of learning, assessment for learning and assessment as learning (Education Reimagined, 2016).

- Assessment of learning is summative and performance-based. Used this way, assessments judge results against established standards and benchmarks. This mostly traditional use of assessment can reveal how the learner and the system are performing over time.
- Assessment for learning is formative, real-time and diagnostic. Used this way, assessments provide immediate feedback both to the learner and to adults on the student’s development of knowledge, skills and dispositions while the learning is actually happening.
- Assessment as learning is self-examination by the learner. Used this way, assessments support the development of metacognition, the understanding of how learners learn and who the learners know themselves to be. This use of assessment provides the kind of self-awareness needed to become a better learner and to develop higher-order skills and dispositions.

With the support of technology, the orientation of assessment for learning could better shift to assessment as learning.

Implementation Guidance

Technology can be used for instant assessment in many different ways such as tracking student progress over time. Perhaps, even more compelling, edtech can also be used to aid formative assessment by helping to boost engagement, identify knowledge gaps and support further/deeper learning (ResourcEd, 2020).

Technology can also support task design for assessment in a variety of ways. It can support the presentation of assessment tasks to students, and it often enables more flexibility in the timing of assessments. Increased clarity of task goals and greater flexibility in timing both give students
Guidance on implementation of the National Smart Education Framework

more control over their learning and assessment thus enhancing opportunities for self-regulation. Technology can make it easier for teachers to monitor and track learner progress (e.g., through the recording of student activities) and to tailor assessments to individual student needs (e.g., through adaptive testing) (Nichol, 2011).

The JISC Assessment and Feedback programme has the dual aims of using technology to enhance the learning and teaching process and to deliver efficiencies and quality improvements. On October 9, 2015, JISC published Transforming assessment and feedback with technology which describes the assessment and feedback lifecycle. The lifecycle is an academic model showing a high-level view of the academic processes involved in assessment and feedback. The lifecycle includes 8 stages (as shown in Figure 6.): specifying, setting, supporting, submitting, marking and production of feedback, recording grades, returning marks and feedback and reflecting. At a more detailed level, the processes also include an assessment scheduling, submission of assignments, tracking of submissions, extension requests and approvals, academic integrity, academic misconduct processes, examinations, the recording of marks, moderation and external examining and finally, student progress tracking (JISC, 2015).

In October 2017, the European Union published DigCompEdu (EU, 2017), a framework for teachers' digital competencies, which states that the use of digital technologies in assessment, learning, management, or elsewhere generates large amounts of data on student learning behavior. Analyzing and interpreting this data can assist in the analysis of routine student learning behavior and improve the accuracy of teachers' decision-making. At the same time, digital technology can directly monitor students' learning progress, facilitate feedback, and allow teachers to assess and adjust corresponding teaching strategies. Besides, the application of digital technology to formative and summative assessment can improve the diversity and applicability of assessment methods.

Figure 6 JISC-The Assessment and Feedback Lifecycle
The evaluation method under technical support pays more attention to the formative assessment and the comprehensive evaluation of students’ competencies in five aspects: moral, intellectual, physical, aesthetics and labor.

When it comes to improving moral evaluation, moral education goals should be scientifically designed to guide students to develop good psychological quality and behavioral habits, according to the physical and mental characteristics of students at different ages.

- **Promoting academic evaluation.** By 1). combining formative assessment and summative assessment, 2). stressing classroom participation and 3). guiding students to develop a good learning climate.

- **Strengthening sports evaluation.** By 1). Guiding students to develop good habits of exercise and healthy lifestyles, 2). exercising strong will and 3). cultivating the spirit of cooperation.

- **Improving aesthetic evaluation.** By 1). Promoting students to form artistic hobbies, 2). enhancing their artistic literacy and 3). comprehensively enhancing their ability to feel beauty, express beauty, appreciate beauty and create beauty.

- **Strengthening the evaluation of labor education.** By 1). developing labor habits in practice, learning to work and learning to be diligent and thrifty and 2). involving students’ labor learning process in students’ comprehensive literacy files (MOE, 2020).

The above 5 aspects for students’ comprehensive literacy should be considered when reimagining assessment. And ICT can be used to strengthen formative assessments by 1). concomitantly collecting data on students learning processes, 2). using multimodal analysis techniques (such as data mining algorithms, content analysis, predictive analytics, system modeling and so on) to diagnose data and 3). using technologies (such as wireless communication technology, data visualization technology, big data technology and so on) to give real-time, actionable feedback of the teaching process to the educator, the student, mentors or coaches and the student’s family or caregivers.

Intelligent technologies can be used to improve a comprehensive evaluation. The intelligent era tends to evaluate learners comprehensively and cohesively. The comprehensive evaluation of learners can be achieved by 1). using technologies (such as expert systems, machine learning, artificial neural networks, genetic algorithms and so on) to construct and optimize the comprehensive evaluation index model, 2). deepening mining and analyzing data and 3). creating an application for digital portraits.

**Recommended Materials**

Assessment and its associated feedback are essential to student learning, as they can help drive individualized instruction that allows all students to be successful (ISTE, n.d.). Well-designed assessments can encourage active learning especially when the assessment delivery is innovative and engaging. Peer and self-assessment, for instance, can foster a number of skills such as reflection, critical thinking and self-awareness, as well as provide students an insight into the assessment process (University of Reading, n.d.).

There is a course to describe the assessment of learning for teachers (Study. Com, 2022), which not only tells teachers the types, plan, validity, reliability and bias about educational assessment but also how to implement assessment in the classroom. Teachers should learn more from this course.

The principles of assessment should be obeyed by teachers, such as validity, reliability, transparency, fairness and manageability. The purpose of
should be understood and mastered by teachers, such as driving instruction, encouraging learning, improving teaching methods and informing students of their learning progress (Opinion Stage, 2021).

In addition, there are many resources about assessment that could be referred to. For example, The Assessment Process-The Four Steps of the Assessment Cycle (Missouri State University, n.d.), 9 Types of Educational Assessment (Formplus, 2022), How to Effectively Use Educational Assessment Tools (ViewSonic, 2019), How Can Online Assessments Help Continue Learning During Lockdown? (ProProfs, 2022), Four Steps to Quality Classroom Assessments (Educational Data Systems, 2019) and How Assessment Improves Learning (Educational Data Systems, 2018).

3.1.3 Learner Community-Building

The Importance of Learner Community-Building

Technology is leveraged as a critical tool to facilitate culturally responsive instruction, thereby instilling a sense of belonging and helping students grow as civic-minded members of the local and global community. Skills and competencies that can be developed and reinforced include, but are not limited to social-emotional skills and digital citizenship competencies.

Social-emotional skills are essential for connecting with others. There are multiple benefits of learning socio-emotional skills such as helping us manage our emotions, building healthy relationships, feeling empathy (Pathways.org, n.d.), increasing academic success, improving self-awareness and confidence, decreasing emotional distress and encouraging advantageous social behavior (allround, 2021).

Digital citizenship is an important skill set that all members of society should possess. It is the responsibility of every individual to act in a manner that reflects positively on themselves and their communities (QQI Assignments, n.d.). Digital citizenship is about creating thoughtful and empathetic digital citizens who can wrestle with the important ethical questions at the intersection of technology and humanity. Digital citizenship should not be a long list of don’t. It should be about the do’s that help create those thoughtful and empathetic digital citizens mentioned above. Those include:

- Using technology to make your community better.
- Engaging respectfully online with people who have different beliefs than you.
- Using technology to make your voice heard by public leaders and shape public policy.
- Determining the validity of online sources of information.

Implementation Guidance

Social-emotional Skills

1) OECD-The Big Five Model

There is a well-known framework in the field of social and emotional skills (as shown in Figure 7.).

This model (OECD, 2019) includes a cluster of mutually related social and emotional skills within five broad domains: task performance, emotional regulation, collaboration, open-mindedness and engaging with others. Task performance includes achievement motivation, responsibility, persistence and self-control. Emotional regulation includes stress resistance, optimism and emotional control. Collaboration includes empathy, trust and cooperation. Open-mindedness includes curiosity, tolerance and creativity. Engaging with others includes sociability, assertiveness and energy. Additionally, the framework includes “compound” skills that represent combinations of two or more
individual skills. Compound skills include critical thinking, meta-cognition and self-efficacy.

2) OECD-PISA 2018 Well-being Framework

Well-being is defined as the quality of people’s lives and their standard of living. Furthermore, it is of growing interest to policymakers and educators around the world. There seems to be a consensus that well-being is a multi-dimensional construct that comprises both objective, material components and subjective, psychological facets.

The proposed modular framework (Figure 8) distinguishes three main dimensions of well-being in addition to students’ perceived quality of life as a whole (OECD, 2019):

- First, well-being in terms of how fit and healthy students are, the education and skills they have and how they feel about themselves and their lives (self).
- Second, well-being in terms of the environment a student is exposed to at school (school environment).
- Third, well-being in terms of the living environment and the circumstances outside of school experienced by a student (out-of-school environment).

Additionally, there are many frameworks for social-emotional skills that could help us more easily master the associated skills. For example: Why Social Emotional Skills are so Important in Middle

![Figure 7 OECD-The Big Five Model](image-url)
School? (Complete Literature, 2020) CASEL’S SEL Framework What Are the Core Competence Areas and Where Are They Promoted? (CASEL, 2021) and 8 Key Social Emotional Learning (SEL) Skills to Develop (Kickboard, 2018).

Digital Citizenship Competencies

Digital citizenship goes beyond conversations about personal responsibility. It is about being active citizens who see possibilities instead of problems and opportunities instead of risks as they curate a positive, effective and secure digital footprint.

ISTE lists five main competencies when it comes to digital citizenship (ISTE, 2021): inclusive, informed, engaged, balanced and alert. Moreover, there are many frameworks on digital citizenship competencies internationally.

1) UNESCO - Refined Framework

In 2017, UNESCO synthesized a number of many frameworks into a 'refined' framework (UNESCO, 2017) (as shown in Figure 9) that identified five main areas of concern.

- **Digital Literacy.** A number of the previous skills domains such as basic IT literacy, information literacy, creation and adaptation were merged into one Digital Literacy domain. Defining this domain in the refined framework is especially important and timely as it is related to one of the global indicators of Sustainable Development Goal 4, namely Indicator 16.2 “Proportion of youth and adults with ICT skills”.

![Figure 8 OECD-Framework Overview of Well-being](image)
- **Digital Safety.** As staying safe and resilient to potential risks is one of the most essential competencies for digital citizenship Digital Safety deserves to be its own separate domain. This domain serves to address the required skills for ensuring digital safety such as adjusting configurations to protect personal information and privacy and blocking harmful content providers and assailants.

- **Digital Participation.** Domains such as communication, collaboration and responsible online engagement were merged into Digital Participation.

- **Digital Emotional Intelligence.** While Digital Safety subsumes specific skills, Digital Emotional Intelligence addresses required values and attitudes for Digital Citizenship such as digital ethics, rights, empathy and respecting diversity.

- **Creativity and Innovation.** It is mentioned as a potential competency to reflect the attainment of opportunities and benefits from ICT through one’s actions.

2) **US - The Framework for 21st Century Learning**

21st century skills refer to the knowledge, life skills, career skills, habits and traits that are critically important to student success in today’s world, particularly as students move on to college, the workforce and eventually adult life. The framework (as shown in Figure 10) includes Learning Skills, Life Skills and Literacy Skills.
Learning Skills. Also known as the "four Cs" of 21st century learning, these include critical thinking, communication, collaboration and creativity. 21st Century Learning demands the exercise of higher-order thinking skills in the process of both teaching and learning. Among the higher-order thinking skills (HOTS), critical thinking, communication, collaboration and creativity (4Cs) are essential and need to be included consistently on a daily basis. Students who were exposed to these 4Cs have proven their efficiency through their mastery of the given content and problem-solving (Chiruguru, 2020).

Life Skills. Flexibility, initiative, social skills, productivity and leadership.

Literacy Skills. Information literacy, media literacy and technology literacy (PANORAMA, n.d.).

3) China - The framework of Core Competencies (Guangming Education, 2016)

On September 13, 2016, the “Core Competencies of Chinese Student Development” divided the Core Competencies (as shown in Figure 11) which regard cultivating "well-rounded people" as the core. It could further be divided into three aspects: cultural foundation, independent development and social participation, which are embodied in the six competencies of cultural heritage, scientific spirit, learning strategies, healthy life, responsibility, practice and innovation.

The Core Competencies of student development refers to the essential character and key abilities that students should have to possess, which can adapt to the needs of lifelong and social development. Furthermore, it is a comprehensive performance of students’ knowledge, skills, emotions, attitudes, values and other requirements.

Figure 10 OECD-P21’s Framework for 21st Century Learning (Battelle for Kids, 2019)
Additionally, there are many frameworks for Digital Citizenship, for example The Digital Competence Framework 2.0 (EU, n.d.), Digital Intelligence (DQ)-A Conceptual Framework & Methodology for Teaching and Measuring Digital Citizenship (DQ Institute, 2017), Digital Competence Framework (Hwb, 2020) and so on.

**Recommended Materials**

Some materials will be recommended in this part that could help parents and teachers to develop children’s social-emotional skills and digital citizenship competencies.

Four social/emotional skills parents and teachers can easily practice with teens to develop teenagers’ social-emotional skills are: listening, assertiveness, emotional self-awareness and understanding nonverbal communication (Andrew Sachs, 2017).

Some questions to consider are, what are social-emotional skills? How can you improve them? (MENTALUP, 2021) tells parents six tips to improve kids’ social emotional development such as defining and verbalizing children’s emotions, approving children’s feelings, trying to build some empathy together, giving kids some space and letting them experience uncomfortable feelings, accepting emotions and correct behaviors and supporting other cognitive skills.

3 ways to help educators develop social emotional skills (Getting Smart, 2018) provides educators with three ways to develop students’ social-emotional skills: infusing social-emotional skill-building activities into professional development sessions, creating a social-emotional learning vocabulary for adults and kids to use and encouraging self-reflection.

7 ways to promote digital citizenship skills in your classroom (Prodigy, 2020) shows educators seven ways to promote students’ digital citizenship skills,
such as emphasizing the importance of online etiquette, teaching students to protect their privacy, helping students stay safe online, promoting media literacy in the classroom, teaching students to protect creative rights, showing students their digital footprint and building healthy usage patterns.

5 ways to teach digital citizenship to your students (The Edvocate, 2017) explores five ways teachers can teach digital citizenship to students including seamless incorporation into the daily lessons, finding the right resources, focusing on topics appropriate for the student’s age group, reviewing comment sections of articles for other areas and examining cyberbullying stories and finding solutions.

3.2.

Digital Learning Environments Conducive to Smart Education

With the development of artificial intelligence, the Internet of Things and other technologies, the learning environment has changed from a closed physical space to a virtual merging physical space which places more emphasis on intelligence, integration and sharing (NELCIE, 2021). A modernized digital learning ecosystem requires an environment where both formal and non-formal education opportunities (UNESCO, 2020) are enabled and accelerated by access to the necessary technology. These digital learning environments allow for learning to occur anytime and anywhere, whether the learner is on campus (Matthew & Halgali, 2019) or otherwise. In addition, the use of various technologies by leaders, educators and students must be guided by a shared set of standards, rules and guidelines around the ethical use of digital information. In the construction process of a digital learning environment, the following principles should be taken into account:

- Service-oriented and teacher-student-centered: the digital learning environment should 1). originate from service, 2). place the users at the center and 3). meet the personalized needs of teachers and students to achieve fast service.
- Application-driven and stand-out characteristics: the digital learning environment should be 1). combined with the characteristics of school disciplines, 2). initiated from the needs of schools and 3). oriented towards the application to improve intelligent and digital capabilities.
- Unified standards on openness and sharing: the internal data of the school should be integrated with social resources to form the research resources in a digital learning environment.
- Integrated innovation and changing model: the construction of a digital learning environment should 1). promote the deep integration of modern information technology with education, 2). improve the quality of teaching and 3). innovate talent training models and teaching methods and other overall educational changes.

3.2.1 Learning Devices and Support

The Importance of Learning Devices and Support

All students and educators need access to a digital learning device. The learning devices in the digital learning environment should be supported by using technology to ensure that students with different learning needs can also access digital resources. In a digital learning environment, all students and educators are provided with access to a digital learning device conducive to smart education and capable of connecting to advanced telecommunications and information services. Support should be readily available to help both students and educators troubleshoot technical issues with such devices (ISTE, 2021).
Technology opens new doors for learning, but students cannot walk through them if the technology is unusable or disruptive to the learning and teaching process. Consistent and reliable technical support removes these barriers and makes it possible for educators to better leverage their use of technology as an effective teaching and learning tool. It also minimizes the time and energy they spend on troubleshooting and problem-solving.

**Implementation Guidance**

There are three aspects of learning devices and support including popularizing personal learning terminals, building and updating rich learning resources and maintaining, updating and upgrading learning devices.

1) **Popularize Personal Learning Terminals**

At present, many countries and organizations are committed to popularizing individual learning terminals and helping students personalize learning from the aspects of advocating 1 person and 1 terminal and emphasizing the provision of inclusive digital devices for students.

In 2021, the OECD released Supporting the Digital Transformation of Higher Education in Hungary (OECD, 2021) which shows that Hungary is equipped with a range of ICT tools for new students. Furthermore, it showed that about 90% of the students surveyed have access to digital devices such as computers, mobile devices and high-speed internet, and almost every student has their own laptop.

In 2021, the ASEM Digital Education Expert Group developed the Working Paper Digital Connectivity: Promoting Eurasian Cooperation in Education in the Digital Age (ASEM, 2021) which mentions the need for all students and educators to have access to inclusive digital learning devices to ensure that students with different learning needs also have access to digital resources.

In 2021, Singapore’s Ministry of Education released their Educational Technology Plan (MOE. Gov. SG, 2021) which states that through the Individual Learning Device Initiative each secondary school student will be provided with a personal learning device to support the personalization of learning, support schools to incorporate the use of personal learning devices into their teaching plans and provide students with seamless access to the network and technical support of the learning environment, so that they can learn anytime and anywhere.

Like what is mentioned above, there is a lot of experience internationally to refer to:

- **1:1.** Schools should have one device per child (known as 1:1 programs), for better continuity of learning between the school and home life experiences. Schools implementing 1:1 should strongly consider allowing students to take home the devices, rather than only using them in school and leaving them in school, as this allows for a more equitable transfer of learning opportunities at home (ISTE, 2021).

- **BYOD (Bring Your Own Device).** Many workplaces and educational institutions have been operating in a high-risk, digital environment due to the ongoing pandemic. More schools are considering implementing a bring-your-own device (BYOD) program as a result. Under the BYOD system, classroom digital devices would be purchased by the school district but students would also have the option to use their own smartphones and tablet computers to compete class projects or access learning resources while at school (Resilient Educator, 2020). When implementing a BYOD plan there are five suggestions (Education IT Reporter, 2022) that should be obeyed: getting buy-ins from teachers, parents and students, creating a responsible use policy, deciding which devices are acceptable, training teachers and educating parents and students on the program’s policies and prioritizing device equity.
2) Build and Update Rich Learning Resources

OER is a freely accessible resource found on the internet. The OER has changed the picture of teaching-learning practices and has numerous benefits. Some of the benefits of using an OER are (LEARN TO TEACH ONLINE, 2022):

- Students through OER can learn from anywhere in the world with just a smartphone and the internet. OER-based teaching has a wider reach compared to other modes of teaching.
- OERS eliminates textbook-based learning redundancies. Textbooks often provide less information than required. This redundant information barrier is overcome by the OER.
- Teachers can minimize their time taken to prepare the course content. The most challenging part of creating an online course is to prepare the course content. Teachers can now directly refer to the OERs available and even prepare a separate course and sell them using an LMS platform.
- Cost efficiency for the students and teachers is high. They do not need to spend too much money on buying books for every subject.
- Users get access to updated information. Unlike textbooks, users can immediately update the information in OERs.
- Students can get a broader perspective on a subject apart from their regular courses.

Now, there are many open educational resources (OER) to learn from internationally.

In the United States resources from thousands of courses have been made available by university-based projects such as MIT OpenCourseWare (MIT OpenCourseWare, n.d.) and Rice University’s (RICE UNIVERSITY, n.d.) Connexions project.

In Ireland, universities received government funding to build open-access institutional repositories (ReSupIE, n.d.) and to develop a federated harvesting and discovery service via a national portal. It is intended that this collaboration will be expanded to embrace all Irish research institutions.

And in the UK, the Open University has released a range of its distance learning materials via the OpenLearn (OpenLearn, n.d.) project and over 80 UK OER projects have released many resources which are used to support teaching in institutions and across a range of subject areas.

On March 28, 2022, the Smart Education of China (Smart Education of China, 2022) was officially launched. Three resource platforms of basic education, vocational education and higher education were launched, as well as the "24365" college student employment service platform. On July 8, the Smart Education of China 2.0 was officially launched and the Smart Education of China was newly redesigned and upgraded.

- The national smart education platform in primary and secondary school has 34,000 resources, which is 3.1 times that of before the initial launch. Since its launch, the average daily page views have reached more than 28.91 million views, and the highest daily page views reached 89.97 million. This has effectively served the "double reduction" notion to improve quality and efficiency in various places while strongly supporting the fight against the epidemic in various places.
The professional teaching resource database of the national smart education platform in vocational education launched with a total of 1189 courses, and 13 new ones have been added. Likewise, a total of 6,628 online boutique courses were initially launched, and 192 new courses have since been added. Lastly, a total of 2,222 video open courses were initially launched, and 213 new courses have since been added.

The users of the national smart education platform in higher education covers 143 countries and six continents. On the basis of the first batch of 27,000 MOOC courses, 850 new course resources and more than 65,000 other resources such as courseware have been added.

The "24,365" employment service platform for college students has accumulated 11.24 million job resources, 7.44 million new job resources, 5.19 million graduates of the class of 2022 and 2.23 million new registrations. Furthermore, the platform has actively pushed job information of over 21.92 million jobs to graduates, with a total of 103 million pushes.

3) Maintain, Update, and Upgrade Learning Devices

Maintaining school facilities is important for providing high-quality education programs. More important, by investing in strong preventative maintenance programs, school facilities can continue to serve students for long periods of time (School Facilities, n.d.). Devices need to be maintained, and teachers need just-in-time help when troubleshooting problems. Whether human or virtual, technical support ensures that the device continues to function, remains up to date and is fully usable by teachers, staff and students (ISTE, n.d.).

On 2 November 2021, the OECD released Supporting the Digital Transformation of Higher Education in Hungary (OECD, 2021), proposing to optimize infrastructure and equipment systems for the implementation of Hungary’s higher education digitalization strategy. It emphasizes the construction of infrastructure with the functions of collecting, storing, managing and analyzing data, ensuring network and technical support, including managing and maintaining infrastructure and establishing relevant policies and standards.

Maintenance items might include (IES, n.d.):

- replacing wear-and-tear parts and consumable supplies.
- repairing or replacing faulty components.
- cleaning equipment.
- monitoring the condition and functionality of networks and equipment, including testing website access and links.
- redeploying equipment.
- updating or upgrading hardware and software, including installing new versions of the operating system.
- adding or deleting users from a system, or modifying user rights and properties.
- backing up stored files.
- documenting trends and patterns in the use of applications or equipment.
- removing and disposing of equipment and applications.

Recommended Materials

In addition to policymakers developing policies to ensure the realization of 1:1 device in the school and classroom, teachers should also understand how to use 1:1 device in the classroom. The references are as follows:

5 steps for implementing a successful 1:1 environment (Edutopia, 2021) introduces 5 steps for implementing a successful 1:1 environment such as defining the goals of 1:1 program, defining the role of the device in the classroom, modeling how to harness the device’s power, putting it away when appropriate and teaching, modeling and supporting information literacy.
5 questions to ask before choosing a 1:1 device (ISTE, 2017) proposed five questions to help guide the discussion about mobile learning in school or district, such as, what do we want to accomplish in the classroom? What can we do with free technology? Do we have the infrastructure in place to support the device? How long will the device remain relevant? and does it serve teachers and students to have only one device?

9 Strategies for managing BYOD in the classroom (The Free Library, n.d.) proposed nine strategies, which are employed by school districts to manage their BYOD programs in a way that ensures that student-owned devices contribute to, rather than detract from, classroom engagement.

### 3.2.2 Seamless Connectivity

#### The Importance of Seamless Connectivity

All students and educators are supported in becoming global collaborators through seamless internet connectivity at school, at home or in the community. This frees learners from artificial time-based or geographical constraints.

Students and teachers cannot take advantage of the opportunities to connect and engage globally or leverage high-quality learning resources without consistent and reliable access to the internet (U.S. DEPARTMENT OF EDUCATION, 2017).

#### Implementation Guidance

The focus of implementing Seamless Connectivity should be to achieve full network coverage and full service. As a result, learners can use mobile devices to learn, entertain and socialize anytime and anywhere, making their study life more convenient by forming a ubiquitous learning environment. To achieve it, the following should be done:

1) **Ensure Equal Access to Internet for All Students**

It is especially necessary to support equal access to digital learning for all learners. At present, there is a major international emphasis on focusing on the most marginalized and building network connectivity through increased investment and the establishment of mechanisms to improve access and equality.

In March 2021, JISC released Higher education strategy 2021-2024: powering UK higher education - how Jisc will support universities towards a technology-empowered future (JISC, 2021) which pointed out that we should continuously eliminate the poverty gap in hardware and network connectivity through infrastructure investments so that students and faculty can have a seamless experience both in-person and online.

In July 2021, the Global Learning Council released Digital Transformation of Higher Education (Global Learning Report 2021) (Global learning council, 2021) which noted that inequalities in education are more serious than before, so equal access must be a top priority. Currently, individual internet access is unequal but higher education can establish mechanisms to improve access and equality to improve internet access.

2) **Connectivity at School**

Achieving campus connectivity is an important aspect of the digital development of education. International organizations and governments have proposed relevant policies and measures to solve the problem of campus broadband access and achieve full coverage of network broadband campuses. To connect at school, there are two things that need to be noted:
Ensure students and educators have broadband access to the internet and adequate wireless connectivity, with a special focus on equity of access outside of school.

Ensure that every student and educator has at least one internet access device and appropriate software and resources for research, communication, multimedia content creation and collaboration for use in and out of school (U.S. DEPARTMENT OF EDUCATION, 2017).

There are a lot of international experiences to refer to achieve full coverage of the campus network. In September 2020, the International Telecommunication Union (ITU), the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the United Nations Children’s Fund (UNICEF) released the report The digital transformation of education: connecting schools, empowering learners (UNESCO, 2020). To address the global challenge of school connectivity and to achieve “Leave No One Behind”, the report aims to help governments and stakeholders develop comprehensive school connectivity initiatives and describes the following four pillars of connecting schools to the internet:

- **Map the schools**: mapping schools and their network access to understand where schools are and what their needs are, so as to prepare for infrastructure construction.
- **Connect the schools**: understanding why schools are not connected to the network and help schools access the network.
- **Finance school connectivity**: helping schools find cost-effective ways to access the network.
- **Empower learners**: providing students and teachers with high-quality solutions, teaching content and platforms.

On April 5, 2021, EDUCAUSE released Student Experiences with Connectivity and Technology in the Pandemic (EDUCAUSE, 2021) which proposed the steps that institutional leaders can take to facilitate network access including:

- Providing more support for reliable internet access such as providing funds support, increasing the number of access points and expanding financial aid packages.
- Expanding investments in device-lending initiatives.
- Encouraging faculty to presume students are under-connected (Vikki, 2020).
- Increasing campus technology support services for device and internet connectivity, and promote these services widely.

In addition, in 2019, UNICEF and the International Telecommunication Union (ITU) launched Giga (UNICEF, 2021) an ambitious global initiative to connect every school to the internet and every young person to information, opportunity and choice. Working initially with 19 countries (and growing), Giga maps school connectivity in real-time, creates models for innovative financing and supports government contracting for school connectivity.

### 3) Connectivity at Home

Learning does not stop at the end of the school day, and access to digital learning resources should not either. Educational leaders should work to ensure learners have access to connectivity and devices when they leave the school grounds so that they are not limited in their ability to experience high-quality connected learning fully (U.S. DEPARTMENT OF EDUCATION, 2021).
New Zealand is exploring ways to support the estimated 145,000 school students in 40,000 households who currently do not have a suitable level of internet access at home to support their learning (MOE. gov. nz, 2022).

Furthermore, the U.S. Department of Housing and Urban Development launched ConnectHome (ConnectHome-USA, n.d.) in 2015 to focus on bringing high-speed internet to low-income communities, so that everyone can participate in our increasingly connected society.

**Recommended Materials**

The COVID-19 pandemic and subsequent restrictive measures have highlighted the absolute importance of internet connectivity—and the crucial role it plays in our everyday lives. The following resources could be used to facilitate seamless network connectivity.

5 tips to get seamless internet connectivity at home clarifies five tips to get started on having seamless connectivity at home—as well as how to stay connected on-the-go such as finding the ideal placement for the router, making sure a phone supports the right frequency bands, tweaking router’s channels and bands, upgrading router, considering mesh and turning on airplane mode (SoyaCincau, n.d.).

Huawei’s school connectivity solution provides a wireless campus network based on AirEngine WiFi 6, which is allowing more and more students access to high-quality digital education resources and creating online learning spaces that can be accessed anytime and anywhere (Huawei, n.d.).

There are six ways to support students without internet access at home (TeachThought University, n.d.). These include getting them involved at school, encouraging parents to take advantage of community resources, starting a tech study hall

During or after school, having students identify resources within their family, ‘spin’ intermittent access as a normal thing and incorporate it into project-based learning.

### 3.2.3 Ethical Use of Technology

**The Importance of Ethical Use of Technology**

To realize the vision of smart education, personal and performance data must be shared between trusted individuals and entities. Systems must safeguard this data from misuse, while ensuring that it is readily available to students, educators and leaders who depend upon it. Considerations may include, but are not limited to: data privacy, interoperability and the ethics of Artificial Intelligence (AI).

With technological advancements over time, data privacy has become more and more complex by the minute as more data is being gathered and processed (Ziroh Labs, 2022). Data privacy is about the confidentiality rights of the individuals involved, the types of data collected and how it is used and shared (SREB, 2016). Now there are many data privacy risks such as operator-data leakage, non-transparent policies, terms and conditions, insufficient deletion of personal data and so on (OWASP, 2021). So, protecting data privacy is very important for every person, which not only could give us the power to choose our thoughts and feelings and who we share them with but also protects the information that we do not want shared publicly (such as health or personal finances) (Matomo, 2014).

Interoperability is the capability of having two or more information systems that are allowed to exchange and use information systematically providing synchronization of all parts (Academia by Sero-soft, 2021). There are many benefits to increasing interoperability in education such as increasing the efficiency of education systems and the use of data between and within schools allowing schools and
teachers to reclaim and reuse information related to technology use (Data Smart Schools, 2019). It also helps educators who can easily collect complete and reliable student data from various sources, which streamlines workflows, eliminates guesswork, facilitates communication and may even address equity gaps within schools (EdSurge, 2020). In this way, providing greater access to data generated within a school might help schools to make more informed decisions and govern their school communities with confidence (Data Smart Schools, 2019).

How to balance the "double-edged sword" effect of artificial intelligence on education? While artificial intelligence brings convenience to education, it also increases a lot of risks such as privacy security and data security. The need for the development of responsible and reliable AI has become a global consensus. International and national policies and regulatory frameworks need to be developed to ensure that these emerging technologies benefit humanity as a whole (UNESCO, 2022).

Implementation Guidance

1) Data Privacy

Personal privacy protection should be promoted. The basic literacy on personal data protection during learning online such as setting up devices, signing in LMSs and navigating learning platforms, are important for personal data security. In order to promote the protection of personal privacy in online learning, government’s policy standards, industry’s technology security system and other stakeholders’ actions should collectively build a safe environment for online learning (Smart Learning Institute of Beijing Normal University, 2020).

In the process of making policy and initiatives, the following principles (STUDENT PRIVACY, 2017) should be obeyed:

- **Transparency**: parents should be notified by their children’s school or district in advance of any disclosure of personal student information to any persons, companies or organizations outside of the school or the district. All disclosures to third parties should also require publicly available contracts and privacy policies that specify what types of data is to be disclosed and for what purposes, and provide a certain date when the data will be destroyed.

- **No commercial uses**: selling of personal student data and/or use for marketing purposes should be banned. NO advertising should be allowed on instructional software or websites assigned to students by their schools, since ads are a distraction from learning and serve no legitimate educational purpose.

- **Security protections**: at minimum, there must be encryption of personal data at motion and at rest and required training for all individuals with access to personal student data, audit logs and security audits by an independent auditor. Passwords should be protected in the same manner as all other personal student information.

- **Parental/student rights**: NO re-disclosures by vendors or any other third parties to additional individuals, subcontractors or organizations should be allowed without parental notification and consent (or students, if they are 18 or older).

2) Interoperability

For data to be exchanged continuously to inform instruction, it must flow between systems through seamless, secure, controlled protocols and shared standards.

To ensure data transmission security, an appropriate protection mechanism needs to be established in the process of data transmission. Moreover, it should use network security protocols such as TLS, IPsec and/or cryptography algorithms recommended by the relevant standards.
Secure Socket Layer (SSL): is a security protocol implemented on top of TCP/IP protocols. SSL supports various networks and it provides three basic security services, all of which are enabled by a public key and a symmetric key (Smart Learning Institute of Beijing Normal University, 2020).

3) Ethics of Artificial Intelligence (AI)

The main purpose of applying AI in the field of education should be to promote learning so that every learner can develop their personal potential. As AI is no longer the technology of the future, education is also taking on the task of helping students understand AI and learn how to interact with AI in both their personal and professional lives. To prepare students for success, teachers need to understand how AI technologies can be leveraged to facilitate learning and solve real-world problems (ISTE, 2021).

- Establish and monitor measurable targets to ensure inclusion, diversity and equality in teaching and developing AI services; strengthen appropriate infrastructure such as internet access, hardware and software to allow the equitable leveraging of educational AI benefits.
- Create AI applications that are free from gender biases and ensure that the data used for development are gender sensitive; incentivize AI applications that promote gender equality; empower girls and women with AI skills to increase gender equality among workforces and employers.
- Establish data protection laws which make educational data collection and analysis visible, traceable and auditable by teachers, students and parents; formulate clear policies regarding data ownership, privacy and availability for the public good.

- Investigate options for striking a balance between open access and data privacy; test and adopt emerging AI technologies and tools for ensuring teachers’ and learners’ data privacy and security; develop comprehensive regulatory frameworks to guarantee the ethical, non-discriminatory, equitable, transparent and auditible use and reuse of learners’ data.
- Facilitate open debates on issues related to AI ethics, data privacy and security, and concerns about AI’s negative impact on human rights and gender equality; ensure that AI is used for good and prevent its harmful applications (UNESCO, 2021).
- Enhance the education of students on the ethical issues of AI. Students need a foundational education on what AI is and how it works; educators’ ethical questions around AI education must start by ensuring equitable access to this learning for all students - across subject areas, grade levels and gender. Then, this education must go beyond simple explanations of how the technology works to include corresponding ethical questions and impacts on society. This need is highlighted in the Digital Citizen standard of the ISTE Standards for Students which asks that “students engage in positive, safe, legal and ethical behavior when using technology.” In light of research and news stories outlining negative impacts of AI technologies, students need this education to make positive and ethical decisions about using AI-powered technologies like facial recognition, social media platforms and cognitive assistants (EdSurge, 2021).

In addition, many reports on the ethics of AI have been published internationally to promote the ethical use of AI in human society. In November 2021, UNESCO issued the Recommendation on the Ethics of Artificial Intelligence (UNESCO, 2021) which proposes four major values that should be followed in the use of artificial intelligence: 1). Res-
pect, protection and promotion of human rights and fundamental freedoms and human dignity, 2). flourishing environments and ecosystems, 3). ensuring diversity and inclusiveness and 4). living in peaceful, just and interconnected societies. The 10 principles for such include: proportionality and do no harm safety and security, fairness and non-discrimination, sustainability, the right to privacy and data protection, human oversight and determination, transparency and explainability, responsibility and accountability, awareness and literacy, multi-stakeholder and adaptive governance and collaboration. 11 policy areas have been proposed: ethical impact assessment, ethical governance and stewardship, data policy, development and international cooperation, environment and eco-systems, gender, culture, education and research, communication and information, economy and labor and health and social well-being.

On 8 April 2019, the European Commission published ETHICS GUIDELINES FOR TRUSTWORTHY AI (EU, 2019), which included four ethical principles and seven key requirements to provide guidance for the development, deployment and use of artificial intelligence. Four ethical principles of trustworthy AI include respect for human autonomy, prevention of harm, fairness and explicability. The seven key elements for the realization of trustworthy AI include human agency and oversight, technical robustness and safety, privacy and data governance, transparency, diversity, non-discrimination and fairness, societal and environmental well-being and accountability.

On 22 September 2021, the UK released the National AI Strategy (UK, 2021), which aims to build the world’s most trusted and innovative AI governance system. Three pillars were proposed including investing in the long-term needs of the AI ecosystem, ensuring AI benefits all sectors and regions and governing AI effectively.

All in all, international organizations and countries have issued documents related to the ethical protection of artificial intelligence to ensure the ethical and responsible use of artificial intelligence in human society.

**Recommended Materials**

Some materials on data privacy, interoperability and ethics of AI will be recommended below for the reader’s reference.

11 tips for protecting student data privacy and security in education technology (Managed Methods, 2020) tells 11 tips on how to protect data privacy: knowing that you have a problem, free is not free, managing app cybersecurity risks, being transparent with parents/guardians, encouraging data protection literacy, monitoring your Google and/or Microsoft domains for installed 3rd party apps, creating a process for vetting apps, main- taining and training your vetting process, not doing it alone, knowing your vendors’ terms of use and privacy policies and compliance are just the beginning.

5 simple tips to help protect your personal data (Norton Life Lock, 2021) gives five tips to help personal data. These include 1). at home, using a mail slot or locking mailbox so that thieves cannot steal mail, 2). before discarding, shred documents, including receipts, bank and credit card statements that contain personal information, 3). making sure to secure home Wi-Fi network and other devices so that criminals cannot ‘eavesdrop’ on online activity, 4). do not automatically provide a Social Security number just because someone asks for it, determine if they really need it and, if so, ask how they will help protect it and 4). finally use strong, unique passwords for all of one’s online accounts.
6 things schools need to know about interoperability (Education Week, 2018) shows what schools need to know about interoperability such as interoperability is not about collecting data, data-privacy questions about interoperability are more complicated than either side that debates those questions acknowledges, interoperability creates the potential for better ed-tech vendor practices, however, it does not guarantee it and so on.

9 ways that artificial intelligence helps improve student outcomes (The Tech Edvocate, 2019) describes nine ways using AI technologies can improve student outcomes for teachers, professors and education administrators.

7 ways that artificial intelligence helps students learn (The Edvocate, 2018) tells seven ways that AI can help student learn. These include: students can receive more personalized tutoring, the computer sets the perfect pace, technology can present material in understandable terms, artificial intelligence helps educators identify learning disabilities, students can use AI to give reliable feedback, educators can have more data and it can make education global.

### 3.3.

Forward-Thinking Governance and Policy Initiatives

The pattern of the internet promoting education reform is still being shaped. Thus, it is necessary to accelerate the study of learning laws and teaching rules in the internet environment. A modernized digital learning ecosystem requires a strategic, long-term commitment from government leaders to develop a national vision and plan for the effective use of educational technology, as well as adequate investment to ensure the plan’s effective and sustainable implementation and continuous improvement. The process should follow these principles:

- fully applying 5G, artificial intelligence, big data, cloud computing, blockchain and other new generation information technologies.
- giving full play to the role of data.
- promoting the digital transformation of education.
- enhancing multi-sector cooperation and improving the ability of systematic planning and overall advancement.
- cultivating a good development ecology by effectively stimulating market vitality, and guiding all parties to participate in New Infrastructure Construction in Education (MOE, 2021).

#### 3.3.1 Develop a National Vision and Plan

The Importance of Develop a National Vision and Plan

For systemic changes in learning and teaching to occur, education leaders need to create a shared vision for how technology best can meet the needs of all learners and develop a plan that translates this vision into action (U.S. DEPARTMENT OF EDUCATION, 2017).

Implementation Guidance

Different countries have different visions and plans in the field of education. The following mainly lists the educational visions of international organizations and some countries for reference.

1) UNESCO- Sustainable Development Goals 4

The Sustainable Development Goals (The United Nations Department of Economic and Social Affairs, n.d.) (SDGs) are a set of goals that serve as a blueprint to achieve a better and more sustainable future for all. The SDGs were adopted by all United Nations member states in 2015 (Amref Health Africa, 2015).
Sustainable Development Goal 4 is the education-related goal of the United National 2030 Agenda for Sustainable Development, adopted in September 2015. Its overall aim is to “ensure inclusive and equitable quality education and promote lifelong learning opportunities for all” (UNESCO, n.d.).

Sustainable Development Goal 4 has 10 targets encompassing many different aspects of education. There are seven targets which are expected outcomes and three targets which are means of achieving these targets (UNESCO, n.d.).

**Seven Outcome Targets**

- Universal primary and secondary education: by 2030, ensure that all girls and boys are given a completely free, equitable and quality primary and secondary education leading to relevant and effective learning outcomes.
- Early childhood development and universal pre-primary education: 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.
- Equal access to technical/vocational and higher education: by 2030, ensure equal access for all women and men to affordable and quality technical, vocational and tertiary education including university.
- Relevant skills for decent work: by 2030, substantially increase the number of youths and adults who have relevant skills including technical and vocational skills for employment, decent jobs and entrepreneurship.
- Gender equality and inclusion: 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.
- Universal youth and adult literacy: by 2030, ensure that all youths and a substantial proportion of adults, both men and women, achieve literacy and numeracy.
- Education for sustainable development and global citizenship: by 2030, ensure that all learners acquire the 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 the appreciation of cultural diversity and of culture’s contribution to sustainable development.

**Three Means of Implementation**

- Effective learning environments: build and upgrade education facilities that are child, disability and gender sensitive and provide safe, non-violent, inclusive and effective learning environments for all.
- Scholarships: 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 enrollment in higher education including vocational training and information and communications technology, technical, engineering and scientific programs, in developed countries and other developing countries.
- Teachers and educators: 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 (The United Nations Regional Information Centre for Western Europe, n.d.).
Different countries have different visions and plans in the field of education. The following mainly lists the educational visions of international organizations and some countries for reference.

2) UNESCO- ICT in Education Policy Toolkit (UNESCO, n.d.)

Referring to UNESCO’s ICT In Education Policy Toolkit, countries can develop plans that meet their national vision. A total of six toolboxes can be used. Each toolbox explains a stage in the planning process. The outputs of each toolbox contribute to the development of the ICT in Education Policy and/or Masterplan.

- Toolbox 1 and Toolbox 2 help produce an ICT in Education policy document.
- Toolbox 3, Toolbox 4 and Toolbox 5 prepare the details needed in the ICT in Education Masterplan.
- Toolbox 6 shows how to conduct consultation meetings, proceed with the approval process and launch the masterplan.

3) EU-The Digital Education Action Plan (2021-2027)

The Digital Education Action Plan (2021-2027) (EU, 2020) is a renewed European Union (EU) policy initiative that sets out a common vision of high-quality, inclusive and accessible digital education in Europe, and aims to support the adaptation of the education and training systems of member states to the digital age.

The Digital Education Plan sets out two strategic priorities and fourteen actions to support them:

**Priority 1: Fostering the development of a high-performing digital education ecosystem**

What will the European Commission do to achieve this?

- Action 1: structured dialogue with member states on the enabling factors for successful digital education and skills.
- Action 2: council recommendation on blended learning approaches for high-quality and inclusive primary and secondary education.
- Action 3: European Digital Education Content Framework.
- Action 4: connectivity and digital equipment for education and training.
- Action 5: digital transformation plans for education and training institutions.
- Action 6: ethical guidelines on the use of AI and data in teaching and learning for educators.

**Priority 2: Enhancing Digital Skills and Competences for the Digital Transformation**

What will the European Commission do to achieve this?

- Action 7: common guidelines for teachers and educators to foster digital literacy and tackle disinformation through education & training.
- Action 8: updating the European Digital Competence Framework to include AI and data-related skills.
- Action 10: proposal for council recommendations on improving the provision of digital skills in education and training.
- Action 11: a cross-national collection of data and an EU-level target on student digital skills.
- Action 12: digital opportunity traineeships.
- Action 13: women’s participation in STEM.
- Action 14: European Digital Education Hub.
4) OECD- The OECD Learning Compass 2030

The OECD Learning Compass 2030 was published by the OECD with the aim to articulate core goals and elements of a shared future in a way that can be used at multiple levels – by individual learners, education practitioners, system leaders, policy designers and institutional decision makers – to clarify, connect and guide their efforts.

The publication answered two questions:

- What knowledge, skills, attitudes and values will today’s students need to thrive in and shape their world?
- How can instructional systems develop these knowledges, skills, attitudes and values effectively?

5) WEF- New Vision for Education - Unlocking the Potential of Technology

The World Economic Forum & The Boston Consulting Group published New Vision for Education – Unlocking the Potential of Technology (WEF, 2015). In this report, 16 of the most critical “21st-century skills” are summarized.

Delivering a technology-enabled closed-loop instructional system – one that will help close the 21st-century skills gap – will ultimately require effective collaborations among a complex and interconnected group of policy-makers, educators, education technology providers and funders. When implemented thoughtfully, these collaborations can begin to bring the most effective education technologies to more of the world’s students in an effort to address 21st-century skills gaps.

Figure 12 OECD-Learning Compass 2030 (OECD, n.d.)
6) European Commission: 2030 Digital Compass

March 9, 2021, the EUROPEAN COMMISSION published 2030 Digital Compass: The European way for the Digital Decade (EU, 2021) which proposed four visions and corresponding goals for the digital transformation of Europe by 2030.

The four visions and corresponding goals are 1). increasing digitally skilled population and highly skilled digital professionals, 2). building secure and performant sustainable digital infrastructures, 3). enhancing the digital transformation of businesses and 4). building digital public services.

7) US- NETP 2017

The National Education Technology Plan (NETP) (U.S. DEPARTMENT OF EDUCATION, 2017) sets a national vision and plan for learning enabled by technology through building on the work of leading education researchers, districts, schools, higher education leaders, classroom teachers, developers, entrepreneurs and nonprofit organizations. The plan articulates a vision of equity, active use and collaborative leadership to make everywhere and anytime learning possible.

- All learners will have engaged and empowering learning experiences in both formal and informal settings that prepare them to be active, creative, knowledgeable and ethical participants in our globally connected society.
- Educators will be supported by technology that connects them to people, data, content, resources, expertise and learning experiences that can empower and inspire them to provide more effective teaching for all learners.
- Embed an understanding of technology-enabled education within the roles and responsibilities of education leaders at all levels and set state, regional and local visions for technology in learning.
- At all levels, the education system will leverage the power of technology to measure what matters and use assessment data to improve learning.
- All students and educators will have access to a robust and comprehensive infrastructure when and where they need it for learning.

![Figure 13 WEF-Students Require 16 Skills for the 21st Century](image-url)
8) China: Notice on Strengthening the Informatization Work of Education Management in the New Era

In March 2021, the Ministry of Education issued the Notice on Strengthening the Informationization Work of Educational Management in the New Era (MOE, 2021). By 2025, the information system of education management in the new era will be basically formed, with the information system being optimized and integrated, and the level of integration will be greatly improved; the data silos will be opened and the data efficiency will be fully developed; the one-stop online service will be flexible and convenient, with the "one-stop online service platform" being popularized in depth and the service experience will be obviously improved; the modern education management and monitoring system will be basically formed and the application ecology of multiparticipation will be basically established; and finally the scientific decision-making, management precision and personalized service level will be improved, so as to support the construction of a high-quality education system.

Recommended Materials

“Affordable Computing for Schools in Developing Countries” is designed to assist education officials in developing countries with planning and executing effective affordable computing initiatives in primary and secondary schools. It reviews the immediate and future benefits of integrating computing solutions into educational institutions and presents a model for assessing the TCO of computers for public schools in developing countries (VITAL WAVE CONSULTING, 2008).

The ISTE Standards provide the competencies for learning, teaching and leading in the digital age, providing a comprehensive roadmap for the effective use of technology in schools worldwide (ISTE, n.d.).

If you want to learn more about this part, you can also check out these two materials: Building Technology Infrastructure for Learning (U.S. DEPARTMENT OF EDUCATION, 2017), #GoOpen District Launch Packet, both of which are available for reference in this section.

3.3.2 Build Infrastructure Capacity

The Importance of Build Infrastructure Capacity

Government leaders should deploy, maintain and update advanced telecommunications and information services — including both wired (e.g., fiber) and wireless (e.g., mobile broadband) networks — necessary to ensure that all communities including those that are rural or otherwise remote, are connected to high-speed internet. Fiber is the fastest and most reliable connection to the internet.

Implementation Guidance

On April 18, 2022, EDUCAUSE released 2022 EDUCAUSE Horizon Report—Teaching and Learning Edition (EDUCAUSE, 2022) which notes that blended learning spaces require significant investment in new facilities, as well as equipping existing classrooms with more advanced audio and video technology to support live and distance learners.

In June 2022, the Global Learning Council released Digital Transformation in Higher Education (Global Learning Council, 2022) which states that blended learning requires scholars to use not only laptops but also secondary displays, high-quality headphones or microphones, production lighting, fast broadband connectivity and physical spaces that avoid distractions.

“New Infrastructure Construction” (MOE, 2021) was first proposed at the Central Economic Working Conference in December 2018. Specifically, it calls for the educational infrastructure to be enhanced to provide the basis for blended learning.
“Guidance on Promoting the Construction of a High-Quality Education Support System for New Infrastructure Construction in Education” issued in July 2021, by the Ministry of Education and other five departments emphasizes the following six aspects:

- Strengthening the trustworthiness and safety of networks and connections. For example, creating a sensibility of threads and intrusion of the internet, and usage and security of information systems in terms of warning and monitoring. This guarantees a “green” network for kids to keep away from harmful information, eyesight damage and internet addiction.
- Upgrading ICT infrastructure in education. For example, connecting all schools and universities in a specific broadband network and upgrading campus networks with 5G and Wi-Fi 6.
- Upgrading smart campus with cyber and physical spaces. For example, redesigning smart classrooms with AI, IoT, VR/AR and HD video Technologies. Facilitating laboratory informatics, collaborations and supervision in terms of data visualization and evidence and deploying security facilities for the campus, food, sanitation and mental health nationwide.
- Harmonizing learning management and administration information systems nation-wide. For example: upgrading a safe and reliable data center with a hybrid cloud; promoting effectiveness, efficiency and efficacy use of data; propelling openness and interconnection of information systems; and widening cyber learning space for education transformation.
- Promoting innovation of teaching, assessment and governance by emerging technologies. For example: popularizing inquiry, cooperative and experiential learning enhanced by emerging technologies; innovating assessment of learning and teaching by using multi-model data for all subjects. Improving teachers’ profession across schools and regions supported by AI, big data, learning analytics and virtual and simulation technologies; promoting administration in schools and effectiveness of educational authorities running and governmental supervision powered by big data and AI;
- Innovating digital resources provision nationwide. For example: developing learning tools and resources with AI, big data and VR/AR for all schools and universities; optimizing digital resources provision and services with all stakeholders involved; and creating a mechanism for the adoption and evaluation of digital resources.

**Recommended Materials**

A guide called Future Ready Schools: Building Technology Infrastructure for Learning provides practical and actionable information intended to help district leaders (superintendents, principals, teachers and other leaders) navigate the many decisions required to deliver cutting-edge connectivity to students. It presents a variety of options for district leaders to consider when making technology infrastructure decisions while recognizing that circumstances and context vary greatly from district to district (U.S. DEPARTMENT OF EDUCATION, 2017).

### 3.3.3 Invest in Human Capacity

**The Importance of Invest in Human Capacity**

Investing in human capacity includes helping teachers:

- Deepen and expand teaching skills set in applying digital pedagogy competency in practice. Understand the skills necessary to advocate for equitable access and create personalized/authentic learning experiences for all students. Establish professional learning goals for applying curriculum standards or pedagogy standards such as the ISTE standards.
Successful integration of ICT into teaching and learning requires rethinking the role of teachers in planning and applying ICT to enhance and transform learning. Education systems need to regularly update and reform teacher preparation and professional development, accordingly, ensuring that all teachers can harness technology for education” (UNESCO, n.d.).

**Implementation Guidance**

1) UNESCO: ICT Competency Framework for Teachers (UNESCO, n.d.)

ICT Competency Framework for Teachers (ICT CFT) is a tool to guide pre- and in-service teacher training on the use of ICTs across the education system. The framework is intended to be adapted to support national and institutional goals by providing an up-to-date framework for policy development and capacity building in this dyna-

As the teaching professions face rapidly changing demands, educators require an increasingly broad set of competencies. In particular, the ubiquity of digital devices and the duty to help students become digitally competent requires educators to develop their own digital competency.

- Reflect on personal strengths and challenges related to using educational technology in practice.
- Explore strategies to personalize learning that fosters independence and accommodates learner needs.
- Learn how to develop and provide alternative assessments.
- Connect with an international community of education change-makers.
- Prepare educators to model effective practice for others in schools or districts.

**Figure 14 UNESCO-ICT Competency Framework for Teachers**
set of competencies teachers need to integrate ICT into their professional practice in order to facilitate students’ achievement of curricular objectives.

2) European Commission: The DigCompEdu framework (EU, n.d.)

This framework is directed towards educators at all levels of education, from early childhood to higher and adult education including general and vocational training, special needs education and non-formal learning contexts. It aims to provide a general reference frame for developers of digital competence models, i.e., member states, regional governments, national and regional agencies, educational organizations themselves and public or private professional training providers.

3) European Commission: Critical Digital Literacies framework (Gouseti et al., 2021)

This framework has identified a range of new and emerging dimensions and sub-dimensions that have so far been overlooked by policymaking and thus offers the opportunity for educators to think carefully through the implications of these new areas on their education approach in their local contexts. It can be seen as a useful tool that can contribute to the ongoing debate in the area of critical digital literacies and can be used as a reference point for educators at the primary and secondary school levels.

This framework provides a comprehensive strategy to document how students access and use ICT resources in and outside of school, and to identify how teachers, schools and education systems integrate ICT into pedagogical practices and learning environments. It allows for an exploration of how system-level factors influence schools’ and students’ experiences with ICT. And furthermore, how the availability and use of ICT interacts with various teaching practices and how these associations correlate with students’ performance in mathematics, reading and science, as well as with other outcomes such as students’ ICT skills and well-being.

Recommended Materials

Ensuring effective distance learning during COVID-19 disruption Guidance for teachers aims to help teachers understand key issues related to home-based distance learning during COVID-19 school closures and design and facilitate effective learning activities. While we fully recognize the complementary relationship between formal and non-formal education and continuity of studies across education and training levels throughout lifelong learning pathways, this guidance includes resources, examples and tips for teachers and educators from pre-primary to upper-secondary level (UNESCO, 2020).

Hands-On AI Projects for the Classroom is a set of guides for teachers who are seeking instructional and curricular resources about artificial intelligence for various grade levels and across a range of subject areas (ISTE, n.d.).

Effective Teacher Professional Development reviews 35 methodologically rigorous studies that have demonstrated a positive link between teacher professional development, teaching practices,
and student outcomes. We identify the features of these approaches and offer rich descriptions of these models to inform those seeking to better understand the nature of these initiatives (Learning Policy Institute, 2017).

### 3.4.
**Overarching Considerations across All Leverage Points**

In implementing the three key leverage points in this framework, government leaders must place several overarching considerations at the forefront to ensure that the modernized digital learning ecosystem is agile, sustainable and meets the needs of all stakeholders. Several overarching considerations are: inclusion and equity, continuous improvement culture and multi-sector cooperation and partnerships.

#### 3.4.1 Inclusion and Equity (UNESCO, 2020)

**The Importance of Inclusion and Equity**

Equity is at the core of the Sustainable Development Goals (SDGs) with Target 4.5 specifically aiming to “eliminate gender disparities 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 (UNESCO, 2021).” Equity requires securing all children’s rights to education and their rights within and through education to realize their potential and aspirations (UNESCO, 2010).

Inclusive education means all children are in the same classrooms and in the same schools. It means real learning opportunities for groups who have traditionally been excluded – not only children with disabilities but also speakers of minority languages.
languages too (UNICEF, 2022). Inclusion requires responding to the diversity of needs among all learners through increasing participation in learning, cultures and communities, and reducing exclusion from and within education (UNGEI, 2010).

Without inclusive and equitable quality education and lifelong opportunities for all, countries cannot succeed in achieving gender equality and breaking the cycle of poverty that is leaving millions of children, youth and adults behind (UNESCO, 2022). Enhancing inclusion and equity could provide the foundation for creating sustainable development and a way of developing innovative solutions to the world’s greatest problems (edpsy.org.uk, 2020).

Implementation Guidance

One Pakistani parent said, “my own daughter aged 8 was unable to hold a pencil to write and has been turned away from mainstream school. Though we paid the fees 5 times more, the understanding of the difficulty of special needs people comes from inclusion in society, not exclusion. If the school and the shadow teacher were a little bit compassionate, my daughter could easily adjust” (UNICEF, 2018). Similar cases abound as most governments do not prioritize the need to fund programs or the education for children with special educational needs and disabilities. Therefore, this guide will provide policymakers with some recommendations on how to develop inclusive and equal education.

1) Pay Attention to Inclusive Learning, Teaching and Assessment

Inclusive learning and teaching recognizes all student’s entitlement to a learning experience that respects diversity, enables participation, removes barriers and anticipates and considers a variety of learning needs and preferences. The design and delivery of teaching, learning and assessment methods that allow all students to engage meaningfully with the curriculum and achieve their full potential.

2) Make an Inclusive and Equal Learning Environment (UNESCO, 2022)

An inclusive and equal learning environment should make all students feel that their differences are valued and respected. Furthermore, that they have equitable access to learning and other educational opportunities and are supported to learn to their full potential (The University of Alberta, 2021). There are many aspects to be considered in creating an inclusive learning environment including the development of policies with an inclusive lens, adequate and disaggregated data about learners, curriculum, teacher ability and attitudes, language and communication, assistive technology, physical access including transport and community and family involvement.

3) Adopt Policies that are Appropriate for your Country

Some provinces and cities in China have taken measures to promote inclusive education. For example, China has proposed “Two Exemption and One Subsidy” (MOE, 2005) or “Three Ex-emption and One Subsidy” (MOE, 2017) and “Learning in a regular classroom” (Fei, 2017). Likewise, Malta released its own policy, Inclusive Education in Schools: Route to Quality Inclusion (Education.gov.mt, n.d.) which delivers on the principles of inclusion and diversity, embraces the concept, values and principles of Inclusive Education into the realm of responding positively to all learners’ diversity and adopts a whole school approach/philosophy to provide a planned and systematic way for how schools are to develop conducive learning environments for all learners.
Additionally, there are many problems that should be considered when developing a policy. Are the needs of diverse student and educator groups heard and addressed? Do policies and approaches ensure the full participation and inclusion of people regardless of their ethnicity, origin, cultural and religious identity, gender, age, socioeconomic status, physical ability or other criteria that may lead to the marginalization of certain populations? Also, are they represented in positions of key decision-making authority?

**Recommended Materials**

There are many actions that could be taken to promote inclusive and equal education for educators.

8 powerful ways to promote equity in the classroom (Prodigy, 2020) could be learned by teachers, such as start with yourself, model equity for your students, be flexible with online learning, address inappropriate remarks, create an equitable classroom environment, accommodate different learning styles, examine your teaching materials and give students a voice.

How to promote inclusion in the classroom (James Stanfield, n.d.) tells teachers that by creating an inclusive climate (build relationships, celebrate diversity, educate yourself, encourage interaction and strengths-based approaches) and teaching strategies for inclusion (differentiate instruction, make objectives clear, adapt, explicit teaching and modeling and have a positive attitude) one can foster inclusive environments.

Five ways to promote a more inclusive classroom (Faculty Focus, 2018) describes five ways to foster a more inclusive classroom for teachers such as promoting a positive classroom climate, embracing students’ diversity, increasing students’ own cultural competence, encouraging student interactions and fostering a community of learners within the class(es).

### 3.4.2 Continuous Improvement Culture

(Simmers, 2021)

**The Importance of Continuous Improvement Culture**

Continuous Improvement Cultures originally is a company culture, referring to an environment in which everyone across an organization is consistently looking for new ways to add quality, productivity and value to the organization (Panorama Consulting Group, 2020).

Now Continuous Improvement Culture is being applied in the field of education. It is hoped that this culture will have a positive and large impact on an education ecosystem, when it comes to: raising educators’ sense of ownership, cultivating a sense of innovation and a sense of practical responsibility, promoting the effectiveness of educational organizations and achieving “change for the better (Product Plan, 2022)”, fostering the improvement of educational quality and so on. Most importantly, Continuous Improvement Culture advocates for a belief that whatever is good today, might not be good enough tomorrow (Viima, 2021). In a word, Continuous Improvement Culture goes about creating a culture in which everyone is involved in continuously improving the organization in a pro-active and constructive way (Symbol, 2022). It is obvious that promoting a culture of continuous improvement is imperative for educational organizations.
Implementation Guidance

1) Continuous Improvement in Teaching and Learning Methods

Continuous improvement is not just about getting better at one thing such as teaching methods or even student results. Anderson (2002) identified multiple organizational conditions that influence the quality of teaching and learning, and accordingly that need to be addressed in a coordinated way in the improvement process over time: teacher development, school and system management, teaching and learning resources (curriculum and materials), instructional leadership development, monitoring and evaluation of student learning and of improvement efforts, teacher working conditions, funding for schools and teacher development and parent/community involvement. Alignment cannot be accomplished simultaneously in all dimensions, hence the notion of progressive alignment. The synergy created from coordinated action across multiple components of the education enterprise produces teaching and learning effects that are greater than the separate effects of those components separately (Anderson & Kumari, 2009).

2) Continuous Improvement in Digital Learning Environment

A digital learning environment is never finished, the same for an educational environment, as it should constantly be adapting to educational developments and insights, technology and new questions from users. Digital learning environments of educational institutions have developed into complex environments that are made up of different systems and applications and institutions must strive to realize this challenge. However, it will be necessary to revise or add certain parts of digital learning environments regularly. This requires organization, management and governance. With new applications, the acquisition, technical implementation, maintenance and efficient use, therefore, must remain a recurring point of attention (www.surf.nl, 2019).

3) Continuous Improvement in Governance and Policy Initiatives

To build the foundation for a continuous improvement effort, it is important to take stock of school or district resources and of educators’ readiness to make meaningful improvements toward achieving the goal and identifying where capacity needs to be built. The steps include assessing the school’s or district’s readiness to engage in a continuous improvement effort, determining the overall focus of the continuous improvement effort, recruiting Improvement team members, identifying improvement team member roles and responsibilities and planning the improvement team calendar (IES, 2020).

In addition, there are many problems that should be considered when developing a policy. For example, are educators and leaders collaborating with stakeholders to continuously collect information on and evaluate educational experiences — including the effectiveness of technology infrastructure, learning content and professional development — in supporting the broader vision around technology-empowered learning?

Recommended Materials

In addition to the above-mentioned, policymakers should understand what to do when formulating policies. School leaders, educators and other stakeholders also can improve continuous improvement culture based on the information provided below:

Continuous Improvement in Education: A Toolkit for Schools and Districts (IES, 2020) which is
designed to help school-and district-based practitioners engage in a continuous improvement effort, to orient school principals, district staff, teachers and other practitioners to the principles and practices of continuous improvement.

8 ways to inspire a culture of sustainable continuous improvement (TRACC, 2021) provides eight ways for leaders to promote Continuous Improvement Culture: leading by example, communicating regularly, asking for improvement ideas, empowering educators, emphasizing the importance of small but incremental improvements, helping share ideas and improvements, celebrating the results achieved through continuous improvement and encouraging participation by keeping the methodology simple.

Don’t stop improving: supporting data-driven continuous improvement in college student outcomes (The Institute for College Access & Success, 2019) shows that institutions need to have accurate and robust centralized databases, as well as an awareness of how to use data effectively.

Building a culture of continuous improvement in the classroom (Strive Together, 2017) tells teachers several key themes: continuous improvement is NOT another initiative, continuously improvement keeps students at the center, continuous improvement is an adaptive challenge, and the professional learning community provides teachers with the opportunity to learn and lead.

3.4.3 Multi-Sector Cooperation and Partnerships (OECD, 2012)

The Importance of Multi-Sector Cooperation and Partnerships

COVID-19 has created unprecedented challenges around the world, especially when it comes to facing uncertain. Although we do not know how things will unfold, one thing is for sure: no one sector – government, business, civil society or academia – will be able to endure alone (WEF, 2017). Multi-sector cooperation and partnerships are needed in an uncertain world.

SDG 17-Partnerships for the Goals: Strengthen the implementation and revitalize the global partnership for sustainable development (UNESCO, 2017) which was proposed by UNESCO serves to promote cooperation among public, non-governmental, business, educational and other sectors (Global Compact Network Georgia, n.d.).

Global initiatives are provided by the European Commission such as the Global Partnership for Education (GPE) and Education Cannot Wait (ECW). GPE is a multi-stakeholder partnership and funding platform that aims to strengthen education systems in developing countries (EU, 2022). ECW is the first global fund dedicated to education in emergencies and protracted crises (EU, 2016).

Thus, the importance of multi-sector cooperation and partnerships is clearly emphasized in such global initiatives.

Implementation Guidance

1) Multi-Sector Cooperation and Partnerships in Teaching and Learning Methods

There is a good case to be made that better teaching and learning are best achieved by departments (Improving Teaching, 2017). Some things can only be solved at a whole school level such as behavior; others, like lesson planning, can perhaps best be addressed by individual teachers. But it is the department that influences teaching and learning the most (Aubrey-Hopkins & James, 2002). Thus, it is departments that become the focus for improvement as a school improves
(Chapman, 2004). Teachers of different subjects think and interact in different ways (Grossman et al., 2001; Spillane, 2005) and consequently, the shared practice of their individual disciplines makes departments distinct “communities of practice (Harris, 2001; Wenger, 2010). Furthermore, professional learning communities and collegial bodies that are tasked to improve teaching and learning, are generally usually found in departments (McLaughlin, & Talbert, 2001).

2) Multi-Sector Cooperation and Partnerships to Build Digital Learning Environment

Multi-sector partnerships can be used in a wide range of areas requiring cooperation using multiple resources (Xue et al., 2020). The implementation of cooperation in a digital educational environment has advantages as it increases motivation, promotes collaboration and allows for the use of new management tools (Chikileva, 2022). The primary goal of cooperation partnerships should be to allow organizations to increase the quality and relevance of their activities, develop and reinforce their networks of partners, increase their capacity to operate jointly at the transnational level, boost the internationalization of their activities and exchange or develop new practices and methods as well as sharing and confronting ideas (EU, n.d.).

3) Multi-Sector Cooperation and Partnerships in Governance and Policy Initiatives

Multi-sector cooperation and partnerships play an important role in two aspects. One could be used in education sector development; another could be used at the funding level. In education sector development, a partnership can be done at different levels starting from household and community and up to the national level. On the other hand, a partnership can be at a funding level where households, community members, non-government agencies and corporate and development partners can support the government’s initiatives in enhancing education sector development. Partnerships require, at a minimum, a policy environment that enables non-state providers to get established and be able to function. Most governments have now formally adopted policies that endorse non-state service provision. Yet in practice, there is frequently little support for such initiatives. So, it is both necessary and pressing for governments to provide support in promoting multi-sector cooperation and partnerships (Ipp-media, 2017).

In addition, there are many problems that should be considered when developing a policy. Are government leaders leveraging the wide, influential reach of the private and social sectors, higher education institutions and other domestic and international non-governmental organizations to provide public services that promote transformative uses of technology for learning? Such cooperative models may be leveraged for a wide range of purposes, including, but not limited to:

- Adaptably overcome new and ongoing barriers to student learning with technology;
- Experiment with innovative approaches to learning with technology and accelerate the scaling of evidence-based solutions.
- Strategically incentivize multi-sector partners to contribute and share their knowledge and resources for the public good.

Recommended Materials

How to better promote the realization of multi-sector cooperation and partnerships, in addition to the above-mentioned initiatives that policymakers should implement, other stakeholders can also refer to the following materials.

Why collaboration will be key to achieving the Sustainable Development Goals (WEF, 2017) introduces that different sectors should be open minded about working together, not afraid to
take risks to collaborate in new ways and to ensure the lessons of these partnership models – good and bad – are shared widely.

Developing multi-sector partnerships in early childhood (NICHQ, n.d.) provides five strategies for partnership-building: 1) do your prep work before you launch, 2) learn in action, not just in theory; 3) build relationships grounded in trust, 4) scrap your assumptions and 5) leverage conveners at the community level.

8 simple steps to effective partnership working (The Northern Ireland Council for Voluntary Action, 2022) introduces eight steps to effectively work for sectors: 1) put your beneficiaries at the heart of any collaboration, 2) agree to a vision, 3) create an appropriate structure, 4) underpin the partnership with an agreement, 5) get the governance right, 6) agree to good guiding principles of collaboration, 7) Leadership is required and 8) always remember collaboration is about people.
CONCLUSION

Technology empowers students and teachers as well as new teaching and learning models. Stakeholders should focus on how to construct and evaluate these. The recommendations are as follows:

- **Students’ knowledge and skill:** with the rapid development of society, the framework of 21st century skills (Battelle for Kids, 2019) characterized as 4Cs, the Chinese students’ core literacy (Research team of core literacy, 2016), the transformative competencies in OECD learning compass 2030 (OECD, n.d.), ISTE Standards (ISTE, n.d.), etc. have been proposed to cultivate students with the knowledge and skills for their well-being in the complex and uncertain world. Within the smart education system, students’ competency for living well in the changing and precarious world must be clearly defined.

- **Teachers’ development:** with technology infused in education, teachers need to develop knowledge and skills suitable for the new environments and society. The competency frameworks of TPACK (Mishra & Koehler, 2006), ICT-CFT from UNESCO (2018), ISTE standards for educators (ISTE, 2017) and the Chinese teacher’s ICT application standard (MOE, 2014), etc. were proposed to provide the guidance and evaluation criteria for teacher’s professional development. In order to promote smart education, the standard of teacher’s knowledge and skill should be created clearly responding to the needs of schools, regions and nations.

- **Teaching and learning models.** If the instructional models neglect students’ personality development, the development of the skills of creative thinking, collaboration, culture awareness and critical thinking will be inhibited. Then, it is difficult for them to adapt to the fast-changing world. Considering physical and virtual learning spaces, synchronous, asynchronous and blended methods empowered by network technology should be encouraged to develop new instructional models for student-centered and teacher-guided structures which could refer to the 10 technology enhanced pedagogies (Smart Learning Institute of Beijing Normal University, 2020). Meaning learning that connects current learning content and skills to deal with working in the future should be promoted through new approaches, like competency-based methods.

The basis for adapting to the transformation of education and for meeting the new demands is the creation and provision of digital infrastructure and innovative learning and administrative environments. In the construction of a smart learning environment, the following factors should also be taken into account:

- **Digital infrastructure:** including broadband internet access, digital devices and access to high-quality digital learning resources which are the basic principles for equitable digitally supported learning, teaching and (virtual) learner mobility. All of this ensures that learners can study easily, be engaged and learn effectively at any time and any place, in any way and at any pace.

- **Investing in the creation and provision of digital infrastructure for education.** Equal access to digitally enhanced education requires widespread access to the internet and technological devices. Moreover, learners need to acquire adequate digital skills in order to master
new technologies.

- Data privacy: educators’ and students’ use of technology needs to appropriately balance the benefits of personalized learning, data-driven decision-making and innovation with the priority to protect and secure personal information.

- Interoperability: in order to create a seamless learning environment and ensure cooperation and exchange of knowledge amongst different institutions, interoperability of digital platforms needs to be ensured.

- Public services: public service for digitally enhanced learning can ensure better support for large-scale education and personalized training while also promoting the development of education fairness and quality improvement.
Online merging offline (OMO) learning
OMO learning is a learning mode that relies on hybrid infrastructure and open educational practices to merge online and offline (i.e., physical classrooms) learning spaces together in real-time while simultaneously seamlessly teaching students in both a physical classroom and online (Huang et al., 2021).

Independent study
Independent study encompasses a range of teaching methods that develops student skills like initiative, self-belief, time management and self-improvement. Students are encouraged to undertake a planned activity under the supervision of a teacher or guide. It also involves group study or learning with an assigned partner. These methods are designed by the teachers carefully to address the specific requirements of a group. Teacher, you also need to plan the process of feedback collection, monitor performance and provide the appropriate resources for independent study (Huang et al., 2020).

Differentiated instruction
Differentiated instruction is the process of "ensuring that what a student learns, how he or she learns it, and how the student demonstrates what he or she has learned is a match for that student’s readiness level, interests, and preferred mode of learning” (Tomlinson et al., 2003).

Personalized learning
Personalized learning refers to instruction in which the pace of learning and the instructional approach are optimized for the needs of each learner. Learning objectives, instructional approaches and instructional content (and its sequencing) all may vary based on a learner’s needs. In addition, learning activities are meaningful and relevant to learners, driven by their interests and are often self-initiated (U.S. DEPARTMENT OF EDUCATION, 2016).

Interactive learning
Interactive learning is a hands-on/real-life approach to education founded upon building student engagement through guided social interaction (Australian National University, n.d.).

Inquiry-based instruction
Inquiry-based instruction is a student-centered, active learning approach focusing on questioning, critical thinking and problem-solving (Edutopia, 2018).

Experiential learning
Experiential learning focuses more on activities and requires students to apply their experiences to other contexts. It is more about the process of learning rather than focusing on the content. Students participate in the activities, reflect and share their experiences, analyze and infer the solutions and formulate plans to apply their learning in new situations. Teachers need to provide an environment for learning and encourage the students to be active. Teachers also need to have backup plans for activities in case of problems. This model is used in most pre-schools today since the other models do not work that well with younger kids. There are courses that can show teachers how to make experiential learning more effective for young kids (Huang et al., 2020).
Project-based learning

Project-based learning takes place in the context of authentic problems, continues over time, and brings in knowledge from many subjects. Project-based learning, if properly implemented and supported, helps students develop 21st century skills including creativity, collaboration, and leadership and engages them in complex, real-world challenges that help them meet expectations for critical thinking (U.S. DEPARTMENT OF EDUCATION, 2016).

Collaborative learning

Collaborative learning is an umbrella term for a variety of educational approaches involving joint intellectual efforts by students or students and teachers together. Usually, students are working in groups of two or more mutually searching for understanding, solutions or meanings or even creating a product. Collaborative learning activities vary widely, but most center on students’ exploration or application of the course material, not simply the teacher’s presentation or explanation of it (Laal & Laal, 2012).

Cyber learning spaces

Cyber learning spaces is an online learning place with a real-name system that is identified by the competent education department or school and integrates financing sources, services and data to support sharing, interaction and innovation (MOE, 2018).

Flipped classroom

A flipped classroom is a pedagogical strategy primarily to deliver lectures in the form of pre-recorded video clips before class and spend class time having students engaged in collaboration and interaction for in-depth learning (Huang et al., 2020).

Design-based learning

Design-based learning is an educational approach grounded in the processes of inquiry and reasoning towards generating innovative artifacts, systems and solutions. It employs the pedagogical insights of problem-based learning (Puente et al., 2013).

Competency-based learning

Competency-based learning is a framework for teaching and assessment of learning. It is also described as a type of education based on pre-determined "competencies," which focuses on outcomes and real-world performance (Lytras et al., 2010). Competency-based learning is sometimes presented as an alternative to traditional methods of assessment in education (Remove Ads, n.d.)

Three Classroom (MOE, 2018)

- Delivery classroom is committed to addressing the problem that rural and one-teacher schools lack teachers and are unable to deliver compulsory courses for students. It provides students in rural and one-teacher schools with online special courses, simultaneous courses or delivers them with appropriate digital learning resources through the internet to promote the equity and balance of education in China.
- Outstanding teacher classroom aims at addressing problems of inadequate teaching ability and low professional level among some teachers. It not only offers teachers opportunities to collaborate with outstanding teachers remotely but also provides them with excellent teaching methods and experiences via videos or live streaming which record typical teaching processes from outstanding teachers.
- Prestigious school online classroom aims at closing the gap between regions, urban and rural areas and between schools. With high-quality schools as the main force, it promotes the sharing of high-quality educational resources on a national scale through online schools, online courses, etc., to meet students’ needs for personalized development.
Three Assessments

- Assessment of learning is the assessment that becomes public and results in statements or symbols about how well students are learning. It often contributes to pivotal decisions that will affect students’ futures (Prayitno et al., 2017).
- Assessment for learning is a tool that teachers use to measure a student’s grasp of specific topics and skills they are teaching. It is a ‘mid-stream’ tool to identify specific student misconceptions and mistakes while the material is being taught (William, 2010).
- Assessment as learning is the use of ongoing self-assessment by students in order to monitor their own learning, which is “characterized by students reflecting on their own learning and making adjustments so that they achieve deeper understanding” (Batstone, 1991).

Pre-assessments

Pre-assessments are administered before students begin a lesson, unit, course or academic program. Students are not necessarily expected to know most, if not all, the material evaluated by pre-assessments. They are generally used to 1) establish a baseline against which educators measure learning progress over the duration of a program, course or instructional period, or 2) determine general academic readiness for a course, program, grade level or new academic program that a student may be transferring into.

Formative assessments

Formative assessments are in-process evaluations of student learning that are typically administered multiple times during a unit, course or academic program. The general purpose of formative assessment is to give educators in-process feedback about what students are learning or not learning so that instructional approaches, teaching materials and academic support can be modified accordingly. Formative assessments are usually not scored or graded, and they may take a variety of forms, from more formal quizzes and assignments to informal questioning techniques and in-class discussions with students.

Summative assessments

Summative assessments are used to evaluate student learning at the conclusion of a specific instructional period - typically at the end of a unit, course, semester, program or school year. Summative assessments are typically scored and graded tests, assignments or projects that are used to determine whether students have learned what they were expected to learn during the defined instructional period (The Glossary of Education Reform, 2015).

Comprehensive literacy evaluation (CLE)

CLE means to cultivate students' comprehensive development of the students' competencies in five aspects: morality, intelligence, physical education, beauty and labor (State Council, 2019).

Core competencies

Core competencies and values are the high-order abilities and humanistic abilities to solve complex problems and meet unpredictable situations. The core competencies have responded to the basic question of what kind of people education should cultivate, which can be divided into three aspects: cultural foundation, independent development and social participation which can further be divided into cultural heritage, scientific spirit, learning strategies, healthy life, responsibility, practice and innovation (Guangming Education, 2016).

One-to-one

One-to-one is applied to programs that provide all students in a school, district, or state with their own laptop, netbook, tablet computer, or other mobile-computing device. One-to-one refers to one computer for every student (The Glossary of Education Reform, 2013).
Ubiquitous learning environment
A ubiquitous learning environment is any setting in which students can become totally immersed in the learning process. To define:

Ubiquitous = pervasive, omnipresent, everywhere
Learning = educational, instructive, didactic, pedagogical
Environment = surroundings, setting, situation, atmosphere

So, a ubiquitous learning environment is a situation or setting of pervasive (or omnipresent) education (or learning). Education is happening all around the student, but the student may not even be conscious of the learning process. Source data is present in the embedded objects, and thus students do not have to DO anything in order to learn. They just have to be there (Jones & Jo, 2004).

New infrastructure construction in education
New infrastructure construction in education is led by the new development concept which includes informatization, facing the needs of high-quality development of education, focusing on the new infrastructure system of networks and connection, ICT infrastructure, smart campuses, learning management and administration information system, innovation of teaching, assessment and governance and digital resources (MOE, 2021).

Information Communication Technology (ICT) in Education
ICT in education refers to the process of comprehensively and deeply using modern information technology in education to promote educational reform and development, and the result is bound to be the formation of a new form of education i.e., information education (Huang, 2011).

Inclusive education
Inclusive education is seen as “a process of addressing and responding to the diversity of needs of all learners through increasing participation in learning, cultures and communities, and reducing exclusion from education and from within education” (UNESCO, n.d.).

Equity
Equity “considers the social justice ramifications of education in relation to the fairness, justness and impartiality of its distribution at all levels of educational sub-sectors”. Equity means that distribution is fair or justified. Equity involves a normative judgment of distribution, however, how people make that judgment will vary (UNESCO Institute for Statistics, 2018).

Two Exemption and One Subsidy
Two Exemption and One Subsidy exempted disabled students in the phase of compulsory education from extras, fees for textbooks and provided a certain number of subsidies for living expenses (MOE, 2005).

Learning in a regular classroom
LRC is an educational policy adopted by the Chinese government for solving the problem of enrollment of children with disabilities in general education schools (Fei, 2007).


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