Transforming Education in Schools
This paper aims to support school leaders who want to develop school-based information communications technology (ICT) plans to enhance learning in their schools. But ICT plans will maximize student success only when they are coordinated with other components of the educational system, such as teacher professional development, curriculum and assessment, school resources, and research and evaluation. The focus of the paper is on the integration of ICT with these other components by school leaders and teachers to support learning that effectively prepares students to be successful in facing the challenges of the 21st century world. By integration of ICT for teaching and learning, we mean that ICT should not be an add-on but an integral enabler of the learning and teaching processes. With ICT, it is now possible to efficiently create digital artifacts to demonstrate and share their learning at their own pace and style anywhere and anytime using a wide range of devices. With ICT, learning is no longer merely about reproduction of knowledge but also about negotiating meaning and creating knowledge; changing the roles of teachers and students in the learning process fundamentally.

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Context for Student Success in the 21st Century

It is important for school leaders to look both inward and outward. On the one hand, they are responsible for managing the organization, operation, teaching, and learning in their schools. On the other hand, they are also expected to be responsive to the needs of their community, be a visionary and be aware of developments and trends at the national and global level. The 21st century world is one that faces constant changes. These changes are driven by the complexity of accelerating rate of technological change especially in the development of social media technologies, explosion in information and the flattening of the world brought about by the Internet. There is now increasing volatility in the world resulting from rapid globalization. The economic locus is shifting as it now is driven by rapidly growing emerging physical and digital economies catching up with developed economies. The global economic and financial systems are now more interconnected. These changes present unprecedented competitive challenges for all countries in the world.

In response to these demands, school leaders are faced with transforming education in their schools so that they can help their students to succeed in living and working in the 21st century with all its challenges. They need to equip them with 21st century skills and competencies to help enable them to have the tools to address problems and issues in a challenging world. They need to develop in them the disposition of career-long learning so that they are able to learn, re-learn, and unlearn to achieve life-long employability in a constant changing and dynamic world. They need to educate their students so that they can help their respective countries to move up the knowledge ladder to be an information economy to fully reap the benefits of the 21st century world. And they need to close the gap in the digital divide and to bring about social inclusion for all.

In order for education in schools to prepare students to succeed, the typical curriculum can no longer be a one-size-fits all standard curricula for all students. It can no longer be one that just offers a few curriculum tracks to prepare students for standardized testing or national examinations. Classroom teaching should not remain didactic teaching to the mean. School-based learning should not be disconnected from real-world learning. School-based assessments should not differ from real-world assessment.

For students to succeed in their learning, school-based learning should leverage ICT fully to enhance the learning experiences of our students by not only providing access to wide possibilities of learning and to allow them to make meaning of knowledge but also by connecting them to one another, with the teachers and with the world. The success of students learning will depend on the desired learning to be achieved to drive the use of ICT and not for ICT to drive the learning.
Personalized Learning. To cater to the diversity of individual differences, interests, and talents in the "classroom" without compromising the fundamentals, students will need to have sufficient opportunities to learn from a personalized curriculum through a variety of teaching approaches so that they can all progress, achieve, and fully participate in learning. In personalizing learning, students will have the opportunity to choose what and how they would like to learn within a specific course of study. Teachers will need to conduct frequent evaluation of student learning so that the necessary adjustments to the implementation of the curriculum and the teaching approaches could be made for every student. To move towards the proposed vision of learning, not only will the teachers need to be knowledgeable of their subject and skilled in teaching, they will also need to be skillful in leveraging ICT fully to bring about the desired learning.

Student Success in Learning with ICT

The possible uses of ICT to support the desired learning for both the teachers and students are numerous. We illustrate with some examples.

To learn actively, students can use the numerous applets such as “To do tasks list” or schedulers in their smartphone to self-regulate or personalize their own learning by planning, monitoring, reminding, and keeping track of their own progress in learning. Teachers can use learning management systems to help their students to build up their own digital learning portfolios that are potentially accessible from multiple devices such as notebooks, tablets, and smartphones from anywhere and anytime with connection.

Social media such as Skype, EduBlogs, Edmodo, Gackit, Lino, Voicethread, and Wikispaces are multi-media applications where students, teachers, and the community can come together to connect and collaborate in participatory learning. These social media platforms allow the teachers and students to upload multi-media resources, to post content, to comment, and evaluate ideas. Many of these social media also provide digital tools to obtain feedback by surveys and polls.

There are excellent free web-based resources and applications available to support deep learning. In the learning of science, there are already free resources such as Molecular Workbench, Wolframalpha and WISE. Molecular Workbench supports the conceptual learning of science at the molecular level by providing simulation and visualization of phenomena at molecular level. WISE provides a learning environment with a range of integrated tools for inquiry-based learning of science.

The web already offers numerous learning resources, tools, and applications, often free of charge, for the teachers and students to personalize learning according to their learning needs, interests, and talents. Of course, for teachers struggling to integrate ICT in their daily lessons, the idea of a personalized learning plan for every student is more of a pipe dream. However, there are already schools such as Henderson Hopkins (a partnership with John Hopkins School of Education) in Baltimore, Maryland that personalizes Learning for all of their students on a school-wide basis. For example, Henderson Hopkins, in recognizing that students have different learning needs, leverages ICT to provide blended learning personalization by combining face-to-face learning with ICT-based learning to maximize the learning of their students.

A Holistic Model for Transforming Education in Schools

Intel offers a model that school leaders can use to develop a school-based ICT plan to support and enable their teachers in the school to leverage ICT to help their students to achieve success in learning that will prepare them for the 21st century (see Figure 1). This model can help school leaders develop local policies and plans that are systemic, integrated, and aligned. These local policies should also be aligned to the national and regional policies.

The model addresses all the components of the educational system to assure student success: professional development, curriculum and assessment, information communications technology, sustainable resourcing, and research and evaluation, all within the context of educational leadership and national and local policy. The model allows for the integration of all these components so that they are coordinated and mutually reinforcing. Through the alignment of these components with national vision, policies, and programs, the model increases the impact of the education system on student success.

![Figure 1: Intel’s Model for School-Based ICT Planning.](image-url)
Leadership

Leadership, at the national, regional, and school level, is absolutely critical in ensuring that teachers have the knowledge, skills, and dispositions to help the students in the school to achieve success in their learning as envisioned by the school. Many highly effective educational systems are led by far-sighted ministers who establish visions, policies, and programs that guide and resource their schools. To achieve student success, it is recommended that visionary school leaders21 should, in turn:

• work with the key stakeholders to establish a vision of learning for the school;
• communicate the vision to all stakeholders;
• work collaboratively to develop an implementation plan within a sufficient time frame that secures a buy-in for the proposed plan;
• provide leadership in the implementation which will include, among others, empowering the teachers and students as well as bringing in extra resources such as leveraging expertise of external stakeholders and forming appropriate partnerships;
• evaluate the progress of implementation and encourage action research to enhance learning with ICT; and
• make the necessary adjustment to implementation based on the outcomes of evaluation.

In order for school leadership to succeed at the school level, there should be alignment of the vision of the school with the regional and national vision for learning. The regional and national leadership should provide the necessary support and conditions for individual schools to fully realize the implementation of their school plans to bring about student success in learning.

Policy

At the national level, ministries lay out policies for professional development, curriculum and assessment, ICT, and research and evaluation that are focused on transforming the educational system. School leaders who focus on maximizing student success will need to ensure that their plans aligned with these regional and national policies. At the school level, it is recommended that there should also be effective policies and plans to ensure that their teachers are skilled and empowered to guide student learning, that the local implementation of curriculum and assessment support student success, that ICT is available to empower student learning, that resources are continuously available to support student success, and that local research and evaluation reinforce and improve student learning.

Key Dimensions of School-Based Planning

Professional Development22

The teacher is key to helping our students to achieve success in their learning. Hence, it is essential that the school leadership provides the necessary conditions and support for teachers in the school to leverage ICT seamlessly and fully to bring about the desired learning.

In line with best practices, school leaders are advised to formulate policies to ensure that the teachers and the leaders themselves have protected time for professional development and that sustainable financial resources are committed per teacher to enable their professional development to occur. The formal professional development for educators can be in the form of workshops or courses conducted by external experts and by innovators/early adopters among the teachers within the school either face-to-face, through blended learning, or by online learning.23

To achieve success in student learning, it is important that the professional development should not be viewed as a one-off activity at the start of the implementation of the school-based ICT plan. It should be a continued professional learning. Teachers should engage in sustained on-going professional development, both as individuals and as members of professional learning communities.24 By organizing themselves into professional learning communities, teachers will also be able to support each other to find solutions to learning issues encountered in working with the students in the school and to leverage these communities for coaching to accelerate their own growth. Recognizing teachers who are transforming education in their schools/districts in terms of protected time and resources should be part of the professional learning plan.

In addition to providing overall leadership in the use of ICT for learning, it would be helpful for the school leaders to also ensure that the teachers are led and supported by colleagues who are curriculum and pedagogical leaders in the school. In professional development of teachers, both peer mentoring and working with partners and experts on the use of ICT for teaching and learning are equally important. To do so, school leaders should invest in the professional development of these curriculum and pedagogical leaders in the school. When there is appropriate expertise residing at the Colleges of Education, the school should consider developing partnerships with the experts at these Colleges. When there are mutual benefits to be reaped, the school should also consider working in partnership with the learning industry. Partners working with the school should be prepared to journey on a long-term basis with the school on the use of ICT for learning as part of the school community. Successful and sustainable implementation is most likely to occur when the
Professional development should equip the teachers with the knowledge and skills to be able to leverage ICT to bring about the desired active, participatory, deep, and personalized learning for the students. Ideally, teachers should be able to facilitate the presentation of multiple modes (text, audio, video, animation, simulation, etc.) of representing content for their students, to allow the students to have access to a variety of learning tasks and to be able to demonstrate their understanding in multiple ways as well as to be given choices in their learning so as to keep them engaged and interested.25 The specific knowledge and skills required26 should include:

- knowing the content of the discipline (subject matter knowledge) well and the curriculum deeply (curriculum development and implementation);
- understanding learners’ characteristics, how students learn27 and their misunderstanding (learner psychology and pedagogical content knowledge);
- designing the necessary learning conditions by using a variety of teaching and learning strategies (pedagogies) to address the diversity of students in class;
- assessing the effectiveness of the learning conditions designed through formative and summative assessment of student learning as well as action research which include project/program evaluation, and;
- acquiring the relevant ICT skills to integrate ICT into the curriculum (ICT skills and technological pedagogical content knowledge28).

Professional development should address the various learning scenarios where teachers facilitate learning. These scenarios should include face-to-face learning, blended learning, flipped classrooms, independent learning, and personalized learning. Face-to-face learning could be teachers conducting whole-class learning, organizing small group learning within or outside the classroom or one-to-one learning with the help of ICT to present materials, visualize, simulate, and assess by collating student responses. Blended learning is an integrated learning approach which combines face-to-face learning with computer-mediated learning or online learning. In flipped classrooms, students learn the materials through online learning such as watching a lecture on video, reading assigned web sites or conduct online visualization or simulation and return to class for face-to-face discussion, collaboration, and presentation of their understanding facilitated by teachers. Students can also undertake independent learning without the teacher or guided by a teacher. Teachers can more easily develop a personalized learning plan for students according to the learning needs if the development of the learning plan is mediated by ICT.

For the various learning scenarios, teachers should be familiar with the various web-based learning resources and applications which are available to support learning in and out of the classrooms. The possible web-based learning resources and applications for learning will be discussed under the section of curriculum and assessment in this paper.

Teachers now also have a choice of devices for learning from low cost tablets, smartphones to portable notebooks to gain access to learning resources. Today, with cheaper devices available, it is now more possible than before for all students in schools to have their own personal devices to use for learning. The available devices for learning will be discussed under the section of Information Communications Technology in this paper.
Curriculum and Assessment

Of course, curriculum and assessment are important national policies. At the school level, there is a need for the school to review and revise, if necessary, the local approaches to implementing curriculum and assessment so as to enable and not impede the teachers in working towards the desired learning for their students.

The curriculum standards developed in the various subject disciplines should provide the students with opportunities to acquire critical knowledge, skills, and dispositions to meet the requirements of education in the 21st century. More importantly, in achieving the curriculum standards, the organization of the curricular content will need to be structured to encourage deep or conceptual learning rather than the mere learning of content for the purpose of state or national examinations. The curriculum will need to provide opportunities to use disciplinary methods rather than following procedures provided by teachers. The curriculum should also be organized to be sufficiently flexible to provide multiple learning pathways to address the diversity of learners in classrooms even in academically banded classrooms.

As the use of ICT is now pervasive especially the use of social media and gaming among the young people, it is also important for the school to offer, either as part of the curriculum or co-curriculum, courses or modules on media literacy and ethics which should include an understanding of proper net etiquette, safety issues such as not to disclose personal information inappropriately and well-being issues such as to deal with cyber bully issues or to avoid being addicted to online gaming. It is important that the students understand how to use the Internet and digital media safely and wisely for learning as well as for their personal and social interests.

The resources on the web such as Encyclopedia Britannica or the various news web sites such as CNN or BBC, when carefully selected by the teachers, can serve as rich information sources to supplement, complement, and even replace physical textbooks. There are also education specific web sites such as BBC GCSE Bitesize and Curriki which provides learning resources for the K-12 education.

With ICT, students can easily upload the digital learning artifacts that they have created onto a web site so that their work can be appreciated by a wider audience beyond just the teachers and parents in the school. Generally, when students know that there will be an audience beyond the classroom for their work, they are more likely to put in their effort to showcase their learning. Along with a wider audience, teachers can also consider giving incentives such as awarding badges to students as an encouragement of the significant progress that they had made in their learning.
Information Communications Technology

National ICT educational policies often establish programs that guide and resource schools in their use of ICT to support student learning. Local ICT plans should, therefore, build on and coordinate with these national policies and programs. In deploying ICT appropriately for learning, it is critical to provide the necessary resources, tools, and applications to enhance teaching and learning in the various learning scenarios. School leaders should consider making sustainable investment in ICT to provide teachers and students with access to devices for learning, digital learning resources, learning management systems, connectivity, adequate storage and cloud services, and technical support within a secured ICT-enabled environment.

The appropriate investment to be made on ICT will depend on the schools that school leaders and teachers find themselves in. Schools could range from well-resourced schools in the developed countries to the other extreme of poorly accessible and limited resourced rural schools in developing countries. Hence, ICT investment to be made for learning could range from every student with a personalized learning device and connected to the Internet 24/7 to students sharing a limited number of learning devices with limited or no connection to the Internet. School leaders should strive to maximize learning for their students with whatever ICT resources available to them.

In terms of actual devices for learning, schools have many options. They include the traditional desktop computers, portable computers that range from tablets to notebooks to handheld devices such as smartphones. These devices are available on several operating system platforms. With declining costs of devices for learning, it has become possible for more schools to provide each student with a personalized learning device either funded by the school or Government or by the parents of the students or co-funded between the school and the parents. The deployment options for learning devices range from personalized learning devices using, for example, mobile devices for all students in the school, or as required, to having the learning devices centralized at computer laboratories.

Students having their own personalized learning devices should give schools the flexibility to customize and personalize learning for their students. When students have their own personalized learning devices, it should enable them to gain access to information and to be able to process and analyze information anywhere anywhere. They should be able to demonstrate their learning through publishing on the school learning management system, blogs and even personal web sites. They would be able to communicate and collaborate with their peers and experts anytime anywhere. Even in situations where not all students have their own personalized learning devices, it would still be possible for them to leverage ICT for learning. For example, a group of students could share a notebook ICT in class, a desktop computer in a computer laboratory or other shared learning spaces such as the library/media center to undertake inquiry-based learning. A shared computer connected to the Internet will provide the students with access to information and connect them with both resources and people to support their inquiry-based learning.

In order for students to access the Internet safely in the school, there should be a robust secured wireless networking system to support the use of these devices anywhere in the school. The school should also purchase broadband connectivity from an Internet Service Provider by selecting a plan that is affordable and sustainable for the school. In terms of storage, it would now be possible for a school to consider cloud services which include school-based solutions to free online storage from Google Drive* and Microsoft SkyDrive.*

There are a variety of networking solutions available to schools depending on the available budget. For example:

- **Sufficient budget:** If the budget is sufficient, the school should opt for high-speed wireless networking within the school and fiber optics broadband connectivity to the Internet.
- **Expensive high-speed broadband connectivity.** If high-speed broadband connectivity is too expensive for the school, a solution is to cache bandwidth intensive resources such as videos before the lessons on the school servers.

In rural schools, where broadband connectivity is likely to be an issue, Internet connection could be achieved through mobile wireless routers as the telecommunication infrastructure for mobile phones in many countries are far more developed than broadband connectivity.

- **No Internet connectivity:** In the extreme case where Internet connectivity is an issue, a local network could be set up within the school and cache repository of relevant content (locally stored on storage devices such as flash drives and hard disks) could be secured from other schools or from the parent Ministry for use by students in the school.

To manage the learning process, the school will need to select a suitable learning management system (LMS). The systems available include the free systems such as the open source Moodle and commercial systems such as Blackboard. LMS provides a standardized platform to centralize all learning resources which could be accessible to all users anytime anywhere and even anyway. Generally, it has built-in tools to track and report on student learning as well as to give immediate feedback on student learning such as the use of polls and survey tools.

To ensure that teachers and students are able to access digital resources and connect to the Internet seamlessly, the school should ensure that there is technical support for teachers and students in the use of their learning devices. The school can either recruit the technical support staff or outsource the technical support to a service provider through an annual subscription scheme. Often, the school should be able to tap tech savvy students who can use their expertise to supplement the technical support in the school.
Sustainable Resourcing
The school will have to make ICT choices to empower teachers and students in their envisioned learning and to sustainably deploy the necessary ICT resources on a long-term basis. The ICT choices made should be based on available budget to the school. An optimal ICT deployment is one where the ICT choices are made in tandem with the readiness of the teachers to leverage ICT for learning and within the available budget. If ICT is deployed ahead of teachers’ readiness, then the school will be over investing leading to under-utilization of the ICT resources. If ICT is deployed slower than the teachers’ readiness, then the ICT resources provided will not be adequate and will frustrate the teachers in their implementation and may turn the teachers away from leveraging ICT for learning. The school is likely to have teachers who are innovators or early adopters on the use of ICT for learning. For such teachers, the school should encourage them by providing incentives and resources for them to push the boundaries on the use of ICT for learning.

For sustainable resourcing, it would be wise to phase the deployment of ICT resources within the school over 3 to 5 years. If a school is starting from scratch, it would be best to first deploy ICT resources where they are most needed i.e., teachers who are innovators and early adopters so that they can lead the way by identifying issues to inform the school on the most optimal deployment of ICT resources for the rest of the teachers. The cost for basic ICT resources such as school e-mail and school web site could be kept low by opting for free e-mail such as Google mail and web content management systems such as Weebly* or Wix* which offer low monthly subscription cost. For the latter, schools could upload any amount of content on their school web site for a fixed monthly cost.

It is important to bear in mind that capital investment made on big ticket items such as hardware and software for learning, networking equipment, etc. to support the use of ICT for learning will also have a recurrent cost component on maintenance and subsequent upgrading cost that the school will have to bear. In making the decision on capital investment, school leaders should ensure that the associated recurrent cost is sustainable in the long term. More recently, schools can also consider the option of leasing big ticket items instead of purchasing them outright and then pay the subsequent maintenance cost. It is important to include manpower costs for providing technical support on the use of ICT for teaching and learning as part of the maintenance cost so as to free teachers to focus on the use of ICT for teaching and learning. This leasing model may give the school more certainty in determining the annual budget.

It is important for the school to consider partnership with external organizations and the community as the school may not have all the expertise and resources to effectively implement the use of ICT for learning. Partners such as academicians in institutes of higher learning, foundations, ICT companies, telecommunication companies etc. can potentially provide (a) expertise that does not exist in the school e.g., technical know-how, novel pedagogical knowledge, (b) resources such as ICT equipment, and (c) even additional alternative source of funding. In working with partners, it is important for the school to have clarity on the scope of collaboration with stakeholders and external partners; what are negotiable and non-negotiable for the school. This clarity is important to ensure that the goals of the school in using ICT for learning are not compromised or hijacked by the collaborators’ interests.

Research and Evaluation
To ensure effective implementation of the school-based ICT plan, there will be a need for the school to undertake research and evaluation. Research and evaluation should be carried out to:

- assess the programs under the school-based ICT plan being implemented including making corrections to the implementation based on the findings; and
- find solutions to the learning issues encountered in the course of implementation.

In research and evaluation of programs implemented, Intel has, over the years with the assistance of objective third parties, invested in rigorous program evaluation to establish and sustain continuous improvement of the educational approaches and technologies used for learning. The program evaluation protocols developed have led to improvement in the program development efforts as well as to provide evidence of program impact and outcomes in areas such as technology literacy, critical thinking and problem solving and collaboration skills. School leaders could apply the protocols established to evaluate the implementation of programs in the school-based ICT plan.

In finding solutions to learning issues encountered in classroom teaching, Intel has invested in programs on formative and summative assessments of student performance where innovative assessment strategies with technology are integrated into classroom practice.

As a consequence of the knowledge gained from these initiatives, Intel has participated in a number of global initiatives such as Assessment and Teaching of 21st Century Skills (http://atc21s.org) and New Pedagogies for Deep Learning (www.newpedagogies.org) that support the development of new national assessment strategies and new benchmarking of student knowledge and problem solving.
For more complex learning issues encountered during implementation in the classroom, it is important that the school should consider forming teams among the teachers to undertake action research\(^5\) to improve their use of ICT for learning. Action research is about teachers applying a systematic methodology to understand and resolve learning issues in the classrooms and in the school. Essentially, the methodology involves (1) identifying and scoping the learning issue to be studied, (2) gathering the necessary information about the learning issue (from the classroom and literature), (3) planning and implementing a systematic approach to collect data on the learning issue, (4) analyzing the data collected, (5) finding a solution, and (6) sharing the findings with colleagues.

When action research is carried out collaboratively with other teachers in the school and informed by educational research, it would most likely lead to an improvement in pedagogical and assessment practices of the teachers in the school. With respect to the use of ICT for learning, the possible action research areas that could be considered range from a basic study to determine the effectiveness of the models currently used in the school for learning a particular subject with ICT to a more advanced study to leverage ICT for real-time formative assessment by providing the essential feedback to inform subsequent teaching and learning.

### Development of School-Based ICT Plans for Learning

In the Educational Policy Brief commissioned by Intel, Kozma provided a 4-phased model of policy development on the use of ICT for learning at the district or country level.\(^6\) The four phases in this model include (1) Envision the future, (2) develop a master plan, (3) implement initiatives, and (4) evaluate and adapt.

This 4-phased iterative model can also be applied to help school leaders to undertake planning on the use of ICT for learning in their schools.

The school leaders’ toolkit for school-based ICT planning for learning will be available as a separate resource to support the planning of the use of ICT for learning in schools. The toolkit will provide school leaders with further elaborated information on the 4 phases in the model. The elaboration will address the 7 dimensions in Intel’s model for transforming education in schools (see Figure 1). The materials to be included in the toolkit will be sets of documents (exercises, readings, video clips, case studies, bibliographies, and other resources) designed to take school leaders step-by-step through the planning process and develop an ICT plan that will be appropriate for their school and national context.
Conclusion

School leadership is critical to the successful education transformation when integrating ICT for teaching and learning. To transform education in the schools, school leaders should not leverage ICT merely to enhance existing paradigm of learning. School leaders should go beyond just preparing students for standardized assessments or national examinations to preparing them to successfully face the challenges that the test of life brings. ICT should be leveraged to push innovations in learning that are student-centered and relevant in preparing students for the real world of the 21st century. This involves systemic change, aligned with national policy, in which the use of ICT is coordinated with professional development, curriculum and assessment, sustainable funding, and research and evaluation.

Figure 2: Intel's Model for Policy Development on ICT Use for Learning.
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See, for example, Wolfe, R.E., Steinberg, A. and Hoffman, N. (2013), *Introduction*. In R.E. Wolfe, A. Steinberg and N. Hoffman (Eds.), *Anytime-Anywhere: Student-Centred Learning for Schools and Teachers* (pp. 1-12), Cambridge, MA: Harvard University Press. See also (a) Access the Center at http://www.iste.org/ and students @istecenter.org


See http://www.backp.org/.


