



# Digital trends and use in enabling Education

## A market scan

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# Market Scan Summary

## Approach

- During February and March 2019, the KPMG engagement team undertook a review and analysis of current digital trends, technologies and drivers supporting education delivery, with a particular focus on the K-12 education sector
- The review included an examination of the SDTS Data Room artefacts, desktop research identifying trends and digital technology use nationally and internationally, and by searching across the KPMG national and international partnership for real world exemplars
- The market scan has been limited to digital technologies that are either maturing or experiencing early adoption, and discounted technologies posited as having only a potential or theoretical application but without current evidence of adoption
- The scan also considered other major technological directions that could have implications for the K-12 education sector
- This market scan review is comprised of three main parts
  - An identification of the drivers of technology supported pedagogy,
  - An overview of leading technology clusters, and
  - Examples of their adoption in educational jurisdictions which are outlined in brief case studies
- A market scan of this nature is always point in time. This scan reflects observations and experience as at early 2019.

## Overview

- Like many industry sectors, the K-12 education sector has shown exciting growth in effective digital technology integration over recent years. Driven by advances in big data and analytical capabilities, the desire to have a more granular view of a child's learning journey is becoming a reality. This enables personalised learning on an effective scale by matching content, difficulty level and curricula to a child's individual learning needs
- Digitally enhanced learning and teaching, through variable applications, platforms and media, is facilitating greater equity and accessibility in education through flexible learning approaches and flexible learning delivery models better suited to the individual needs of students
- The increasingly high quality and web-accessible learning content is supporting teachers to design and deliver more engaging and interactive lessons, with content that is accessible anytime, anywhere
- In a constantly online world, the focus on safety and security of children, and importantly their personal information, is key that will continue as both inappropriate use and cyber attacks become increasingly common and pernicious, and internet content continues to grow exponentially. Security product vendors are responding in kind ensuring safety of students and their data
- Wireless connectivity across learning environments is now a necessity for students and teachers, wireless presentation and casting technologies are enabling collaboration, presentation of work and discussion in real time, in their learning space, across spaces and across countries
- STEM (and STEAM) continues to drive uptake of computer aided design and fabrication technologies, including 3D printers and CNC cutters and routers, and is also driving an increasing variety of robotic technologies, from tiny bots to near human size bots, that require skills in coding, logic and problem solving to master.

# Market Scan Purpose

## Scope of this document

- The SDTS strategy is being formed based on a range of different inputs from Departmental research, external thought-leadership, the SDTS' human centred school engagement program amongst others
- The purpose of the market scan is an additional input to determine whether there are digital technology uses in education or elsewhere in the market that may have been omitted from these other inputs
- As such, the Market Scan has been developed by :
  - Listing major drivers of change in industry and education
  - Outlining the main digital technologies that are being adopted, largely internationally to aid with insight, and
  - Summarising a range of key digitally enabled educational trends
- From this position, the report then provides an example case study of an application of digital technology to enable or augment that educational trend
- This report is not intended to be a comprehensive analysis of all digital technologies deployment in different learning environments but an input into the SDTS process
- Use of this document as an input into the SDTS will ensure that the opportunities for the Department are not missing any major digital category and provides some evidence that these digital enablers can be successfully adopted

## Reviewing this document

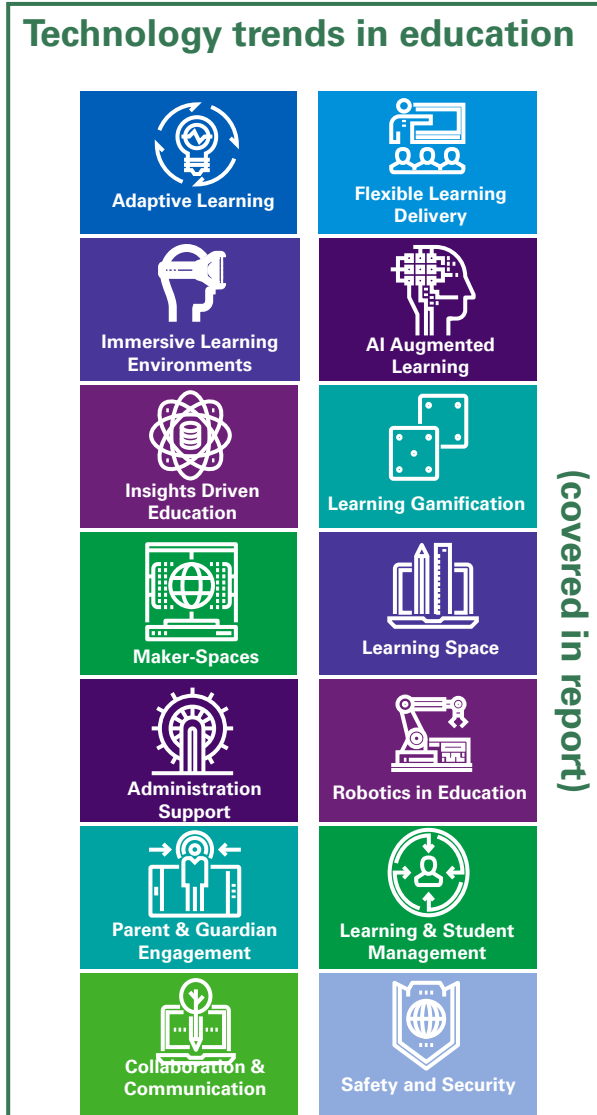
- Noting the scope of the document as outlined opposite, the SDTS project team seeks to gain feedback from reviewers on :
  - Have any major digital technology trends been missed ?
  - Are there major examples of digital technology adoption in schools that have been omitted that the SDTS team should be aware of ?
- The SDTS team will enhance the market scan with feedback if this is material to the inclusion of the relevant trend or case study in a likely initiative for SDTS or will respond to the feedback with how it will be covered in the SDTS process

# Market scan overview

## Drivers of change



- Changing role of the teacher
- Demand for digital literacy
- Rapid growth in new media
- Demand for digital interaction
- Increasing assessment and measurement of learning
- New learning delivery models



## Key digital technologies



- Artificial Intelligence and Machine Learning
- Robotics
- 3D Printing
- Drones
- Internet of Things (IoT)
- Biometric Authentication
- Immersive Environment (AR/VR)
- Big Data
- User Analytics
- Collaboration Technologies
- Personalisation Engines
- Gamification Technologies
- Cybersecurity
- Sharing Economy Platforms

# Key digital technologies



*There are numerous nascent and maturing digital technologies in the market that are disrupting traditional business and operating models. Some of these have clear potential for use in the education sector and are influencing technology trends.*

**1 Artificial Intelligence and Machine Learning**

Artificial intelligence involves the application of advanced analysis and logic-based techniques, including machine learning, to interpret events, support and automate decisions, and take action

**2 Robotics**

The engineering, construction and operation of robots. Robots are being applied in numerous scenarios, from educational robots helping students to write code, research robots exploring inhospitable places, to remotely operated robots performing surgery.

**3 3D Printing**

3D printing involves the use of a 3D printer to create physical objects from digital models through additive construction

**4 Drones**

Unmanned aerial vehicles that may be either remotely or autonomously controlled. Advanced drones are being used for a variety of applications – from aerial security monitoring and surveying, to delivering packages and firefighting

**5 Internet of Things (IoT)**

The Internet of Things (IoT) is the network of connected devices that can sense and communicate with their external environment. IoT devices are being used to support predictive maintenance of assets, traffic monitoring and a host of other applications

**6 Biometric Authentication**

Uses biometric characteristics or traits to identify or verify users. Increasingly commonplace in access technologies, including smart devices, as well as for physical site access. Common biometrics used for authentication include face and voice recognition, fingerprints and irises

**7 Immersive Environment (Augmented / Virtual Reality)**

The realistic emulation or augmentation of scenarios, include with virtual (VR) and augmented reality (AR) technologies. VR provides a virtual 3 dimensional environment, while AR involves the augmentation of real-time real-world information with virtual objects

**8 Big Data**

The use of advanced analytic techniques such as predictive and behavioural analysis to analyse massive data sets, often involving multiple data stores in a data ecosystem. The analysis of big data sets has the potential to uncover valuable insights

**9 User Analytics**

User analytics is the use of data to understand the composition, needs and satisfaction of the user. Also, the enabling technology used to segment users into groupings based on behaviour, to determine general trends, or to develop prescriptive and predictive strategies

**10 Collaboration Technologies**

Collaboration technologies enable the sharing of voice, video, documents and data among multiple users and systems. It can include voice, video, chat and co-authoring tools, and can be enabled on digital devices such as tablets, smartphones, laptops and personal computers

**11 Personalisation Engines**

These software solutions analyse usage and behaviour of individual users to apply context and deliver targeted content through digital channels. They predominantly support three use cases – marketing, digital commerce and customer experience

**12 Gamification Technologies**

The use of game design principles to engage and motivate people to complete tasks in a non-game setting. Gamification is seeing application across learning, marketing, recruitment, health and work contexts

**13 Cybersecurity**

Cybersecurity technologies are evolving to meet the evolving threat environments they face. They include advanced anomalous detection methods, identity management, and automated threat responses

**14 Sharing Economy Platforms**

Online marketplace platforms that match the short-term availability of assets with demand. Uber and Airbnb are obvious examples, but the economy extends to underutilised office spaces and rooms, to clothing, caravans, and many other items

# Drivers of change

*As technology continues to generate profound changes across societies and enterprises globally, and is even seeing the emergence of previously unimagined economies, it is no surprise that even those institutions once considered 'traditional' are being pressured to change.*

## New learning delivery models

- Driven by technology, new learning delivery models are improving accessibility to more students and in-turn generating greater demand.
- Flipped learning, adaptive learning, online learning, and other technology-enabled learning delivery modalities are providing variety and interest, improving outcomes and are gaining greater adoption. Learning is becoming personalised on a sustainable scale
- The proliferation of low-cost computer-aided design and fabrication technologies are fuelling the uptake of project-based learning methods that drive collaboration, creativity and problem solving



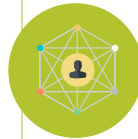
## Demand for digital interaction

- As the internet and smart devices achieve record levels of societal penetration, interacting and transacting digitally with schools is becoming the expectation. It is also providing significant efficiencies
- Parent or guardian engagement in a child's learning is recognised to result in more positive learning outcomes for children, and they are expecting greater online visibility of their child's learning and progress
- Digital collaboration tools and social media platforms are making it easier for parents and citizens to communicate with schools, and challenging the notion that parent/teacher and other interactions must be face-to-face



## Changing role of the teacher

- As teachers increasingly amalgamate technology and assist students to use technology, their roles are evolving to include technology and learning 'mentors' or 'guides'
- More flexible learning delivery models with more engaging approaches require the ongoing review and development of pedagogical approaches, lesson construction, and the effective integration of technologies into those learning and teaching experiences and activities. Teachers are becoming digital producers and orchestrators
- Learning is becoming more student-centric, with students gaining more control of their learning, subject matter and preferred learning approaches, requiring teacher's adaptation



## Increasing assessment and measurement of learning

- The rapid design and deployment of assessment tools, big data and advanced analytics, is making the personalised learning experience a reality and increasing the demand for greater learning progress visibility at the individual level
- From tracking country-level PISA scores, to comparisons of NAPLAN results across states and schools in Australia, more detailed performance measurement and accountability exists across all levels of education
- Parents and guardians are making data-driven choices when selecting schools for their children, impacting enrolments and affecting property values in desirable catchments. This is driving expectations of more granular school performance measurements



## Requirement for digital literacy

- Recognising the need to prepare children for the jobs of tomorrow, including those that will no longer exist due to disruption by automation, schools are increasingly expected to develop digital literacy regardless of a child's personal circumstances and their ability to access technology at home
- The pervasive nature of technological change is requiring digital capability uplift across the population. As legacy technologies are transition into obsolescence and new ways of working become the normal, teachers, administrators, school leaders and students all require higher levels of digital literacy



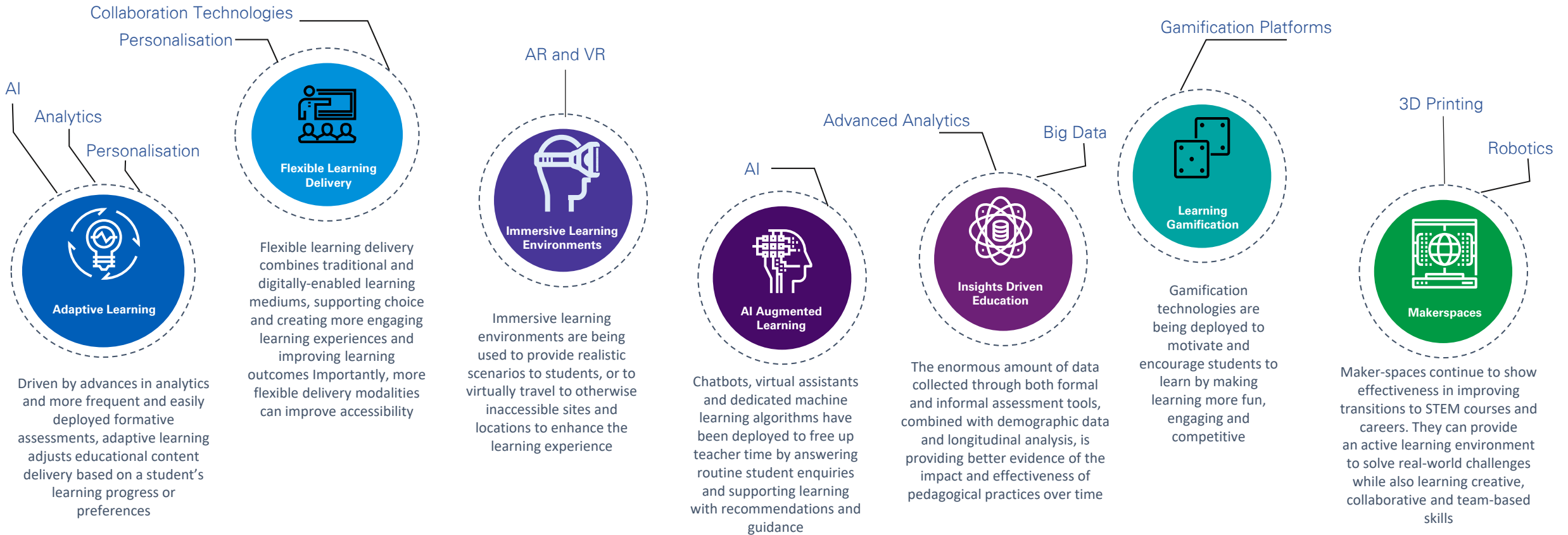
## Evolving media and capabilities

- Media, and social media, platforms are rapidly evolving and offering new and novel ways to effectively deliver learning content and to engage in learning, including through the large-scale provision of industry-recognised qualifications and courses
- Becoming a publisher is simpler than ever before, offering opportunities for co-created learning content and a proliferation of content providers
- Immersive learning technologies, digital assessment tools, learning applications, video technologies, chat and collaboration tools, and other forms of learning media are vying for space with an increasingly crowded curriculum



# Technology trends in education

The education sector is seeing disruption to traditional models driven by the emergence of new technologies and the demands of consumers and stakeholders. New models of learning delivery are improving the accessibility, variety, personalisation and effectiveness of learning, and providing better measurement of learning outcomes.





# Technology trends in education (cont.)

Seamless learning environments



Learning spaces are being transformed to support more seamless learning experiences across both the physical and virtual environments. They are being designed to enable interaction, collaboration, team work, presentation, experimentation and reflection through both social and individual learning

Biometric devices

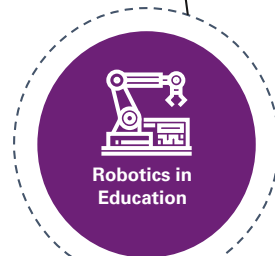
IoT

Automation



Administrative processes are increasingly being augmented or automated by technology. Attendance management, payment collection, financial management, and asset monitoring are seeing the introduction of biometric, IoT and automation technologies.

Robotics

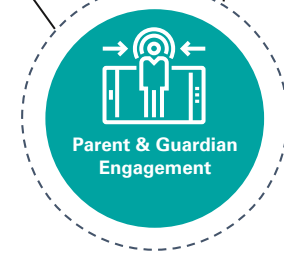


Robotic technologies and their associated coding have cemented their place in STEM learning as essential tools for developing creative thinkers and problem solvers. They are considered important tools to develop skills needed for future jobs and for solving real world problems

Personalisation

Collaboration technologies

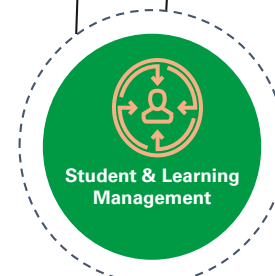
Analytics



Parents and guardians increasingly expect the same levels of digital communication and interaction they get when shopping, banking or consuming services online. Education providers are providing parental visibility to student's learning progress, assessment dates, homework tasks, excursions and absence notifications, and facilitating school and teacher communications, enrolments and payments online

Learning Management System (LMS)

Student Management System (SMS)



Advanced LMSs have incorporated data analytics to recommend personalised learning pathways for students, and to more easily develop engaging lessons with formative assessments. Student Management Systems are providing more efficient administration through better practices, digital transactions and records, and the automation of processes such as absence notification

Collaboration Technologies

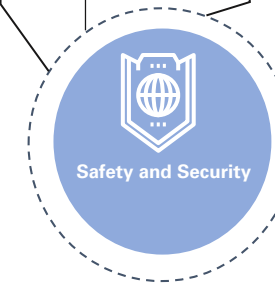


Collaboration, co-authoring and communication tools continue to be deployed across enterprises and organisations to create effective team learning environments, communities of practice, and to share knowledge and learning. The creation and distribution of targeted communications has become easier and quicker

IoT

Drones

Cybersecurity

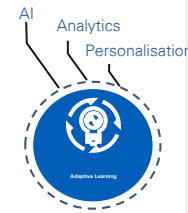


Security and risk mitigation remains a high priority for all educational organisations. The physical and cyber environments are being hardened with technologies that detect antisocial or criminal behaviour, and that deter or prevent the intrusion of unauthorised people or cyber traffic

# Technology Trends in Education



# Adaptive Learning



## Overview

Adaptive learning adjusts teaching content and delivery based on a student's responses or preferences, by leveraging the capabilities of interactive technology platforms. Key technology capabilities to enable adaptive learning include:

- An interaction platform
- Learning and assessment data collection and management
- Learning analytics & recommendation algorithms.

Adaptive learning can alter the sequence, pace, level of difficulty and type of learning delivery based on a student's unique needs. Artificial Intelligence is being used for learning analytics and recommendations. Learning Management Systems (LMSs) are increasingly incorporating adaptive learning platforms and tools.

### North Carolina's Central Piedmont Community College (CPCC) uses adaptive learning technologies to improve teaching and learning and save students money <sup>1</sup>

Established in 1963, CPCC is one of the largest community colleges in the Carolinas, offering nearly 300 degree, diploma and certification programs. 15 courses within the science division implemented adaptive tools where students get assigned lessons in the adaptive course that correspond to the material being taught in lectures and lab sessions. Students spend a week learning in a self-paced manner using the tool, which enables them to increase their exposure to the topic and work as many times on the topic as they wish until they have grasped a deeper understanding of the material. CPCC uses McGraw-Hill Education's ALEKS in a pre-calculus course and Pearson's MyLab Math in a developmental math course along with EdReady – a personalised platform for math readiness assessment

#### Outcomes

By utilising the adaptive learning platform, CPCC's science division has been able to drive classroom learning through digital devices linked to the platform, enabling students to engage with the course content on their own for a week. As a result, the actual classes take place in a lab setting where the instructor has more flexibility to create learning activities not normally available in a traditional classroom. More students are now completing lessons. There also have been immediate cost savings for students – replacing text books and lab kits have led to savings of over \$200 per student.



### Baltimore City's City Springs Elementary/Middle School is a high-poverty school that uses adaptive learning to prepare students for the rigour of newly introduced common core assessments <sup>2</sup>

Principal Richetta and her team introduced adaptive learning tools to help their students prepare for the rigour of the New PARCC Common Core assessments. The team chose Waggle, a continuously adaptive learning program that helped students become more proficient in ELA and Math in time for the PARCC assessments. The tool enables each student to receive focused support in areas where prioritised improvement was required. The adaptive learning platform provides an environment for students to not just pick up skills in the areas where they struggle, but also in skilling up to meet the more rigorous state standards. The immediate and customised feedback helps students understand the content more effectively and gain confidence in mastering higher order skills.

#### Outcomes

The school saw increases in Measures of Academic Progress (MAP) scores in reading and math. The increase in percentage of students meeting the growth projection was 25% or greater for every grade (2015 over 2014) and in Mathematics, the increase was more than 20%.



### McGraw-Hill Education's ALEKS <sup>3</sup>

The Assessments and Learning in Knowledge Spaces or ALEKS is a web-based adaptive learning tool that uses adaptive questioning to quickly determine what a student knows and doesn't know in a course. ALEKS then instructs the student on the topic the student is most ready to learn. While the student is learning through the course, ALEKS periodically reassesses the student to ensure that learning goals are being achieved and retained.

ALEKS provides holistic courses, complete in their coverage while avoiding multiple-choice questions.

ALEKS is used in mathematics, science and business courses at K-12 schools, colleges, and universities globally



### Pearson's MyLab & Mastering products <sup>4</sup>

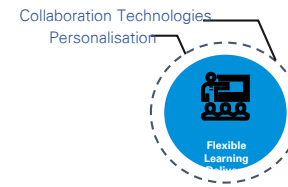
MyLab and Mastering with Adaptive Learning makes studying more efficient and effective for student. The tool assesses student performance and activity in real time and by using data and analytics, personalises the content to reinforce content that target each student's particular strengths and weaknesses.

For educators, owing to the teaching time saved, the tools enable spending more class time in tackling higher-order ideas, explaining complex concepts. This improves the quality of time spent in the classroom

## Key implications

- The Department has some adaptive technologies in place and some educators are using them however the practice is not widespread. There may be an opportunity to leverage existing technologies and capabilities more effectively to gain more widespread adoption.

# Flexible Learning Delivery



## Overview

Flexible learning aims to personalise lesson delivery, allowing students and teachers to focus on discovery and to make their own decisions about their direction and the learning pace. Flexible learning combines delivery technologies such as mobile learning and other online platforms with face-to-face interactions. The aim is to not overwhelm the student with technology but to provide them with more ownership of their learning delivery method. The flexible delivery approach can be well suited for students that require alternative learning approaches to optimise their learning. Some delivery methods include:

- **Face-to-face:** Teachers deliver most of the curriculum while employing online learning in a technology lab or in the classroom to supplement
- **Rotation:** Students rotate on a fixed schedule between self-paced online learning and classroom face-to-face with a teacher
- **Flexible:** Online platform delivers most of the curriculum, while teachers provide on-site support through in-person tutoring or small group sessions
- **Online Labs:** An online platform that delivers the entire course but in a physical location. Students participate in traditional courses in parallel
- **Self-blend:** Online courses taken by students to supplement their school's traditional curriculum. This model is more popular amongst high school students
- **Online driver:** An online platform and teacher deliver all the curriculum with students working remotely. Face-to-face check-ins are also available

### Melbourne Girls Grammar School develops an award winning flexible learning approach built around a wellbeing framework <sup>5</sup>

The school has developed a flexible learning model, in which students and teachers benefit from enhanced active learning time combined with online archives of learning resources. The flexible learning model with a focus on self-paced learning, supplements classroom learning by introducing learning coaches. The school's blended model is built around a wellbeing framework, comprising independent, online learning, personalised feedback and innovative classroom-based teaching. The students are expected to be the architects of their own learning programs. The flexible learning program has been introduced for Year 9 to 12 students. Students have both fixed and flexible experiences in their program, providing them with the ability to plan their daily learning activities around their personal goals and priorities. The students consult their teachers, wellbeing and fitness coaches in deciding their personal goals and priorities. Fitness and wellbeing coaches support optimal wellbeing and self-efficacy by collaboratively managing the physical, emotional, psychological and social components of the students' wellbeing.

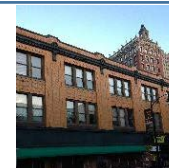


#### Outcomes

Melbourne Girls Grammar was recognised as one of the most innovative schools in Australia by The Educator in leading the way in best preparing students for the future. The school was the only independent school in Victoria to make it to the list in 2017.

### Village Green Virtual Charter High School (VGV) has a flexible learning model driving up graduation rate & college acceptance <sup>6</sup>

From its inception, this school was designed to be a competency and equity based, personalised blended model. Students progress through only after demonstrating proficiency, while the focus on equity is about making sure all students can access the required e-coursework. around 60% of their learning online and 40% in classrooms for face-to-face learning with certified teachers. The school uses Edgenuity as the primary curriculum delivery system. The teacher's role is part skill gap interventionist and part data analyst as they support students in progressing through common core courseware. Each student has workspaces in large learning centres that resemble an adult office environment. Students attend Chromebook-outfitted workshops. The students have access to the Design Space – a makerspace for hands-on STEM related projects such as drone designing and building.



#### Outcomes

In its first four years, VGV posted the highest gains of Rhode Island state's high schools in the assessed content areas of ELA, math and science and outperformed urban school districts. The school has a 97% graduation rate and a 100% college acceptance rate.



### Edgenuity – Online curriculum for flexible learning settings <sup>7</sup>

Edgenuity offers standards-aligned video based curriculum for middle and high school flexible learning environments. The program allows educators to customise the curriculum for their students, who monitor their own progress while completing lessons, assessments and interactive activities. Teachers can access features such as discussion boards, email, and chat to supplement the teaching/learning experience. Teachers can rearrange, add or remove lessons and assignments based on what has already been covered over the platform. Teachers can also adjust content, time and grading scale for individual student, including those with special needs.



### Google's Chromebooks enable a quick flexible learning adoption <sup>8</sup>

Introduced as a cost-saving alternative to Windows laptops, MacBooks and iPads, Chromebooks were introduced in 2011. Chromebooks enable flexible learning in the classroom by delivering in-person instruction, capturing real-time data, timely feedback and personalisation. This flexible learning environment with the classroom environment being augmented with Chromebooks is to strive for a perfect-fit education outcome

## Key implications

- Flexible learning delivery approaches may free-up teacher time and enable them to provide more focussed support in the classroom
- Access to digital devices is necessary for these approaches to be effective
- Different learning delivery approaches can be more suited to student's needs, improving equity and accessibility
- Schools of Distance Education can hold valuable experience and insights into these approaches

# Immersive Learning Environments



## Overview

Immersive Learning Environments are learning situations constructed using a range of immersive tools and techniques which may include game-based learning, simulations, and virtual and augmented reality worlds. The ability of Immersive Learning Environments to simulate real-world scenarios and realistic situations separates them as learning tools from other learning aids. Immersive Learning Environments give learners an opportunity to practice skills and to interact with other learners in a virtual environment. In K-12 education are Virtual Reality (VR) and Augmented Reality (AR) are commonly deployed. VR technologies create computer-generated immersive environments while AR technologies overlay digital information on the physical world to enhance guided interaction. VR and AR applications and tools can support learning activities such as:

- VR simulations for use in science curriculum such as experiments, anatomy lessons, or to manipulate objects
- VR field trips to experience being immersed in specific facilities such as a museum, historical settings or remote places
- Virtual classrooms allow teachers to simulate a classroom experience, events or experiences

### Mount Lockyer Primary School pioneers the usage of VR to augment lesson delivery to students in Australia <sup>9</sup>

To enable experiential learning, the Mount Lockyer Primary school has introduced VR lessons in their curriculum for Year 4 and 5 class. The VR experience provides students with the ability to visit places, or enjoy experiences that may not be practical or possible. Teachers use the VR technology to stimulate the learning process for young students who otherwise have a limited attention span. Students can take a drive in the Lunar Rover, or experience an Oliver Twist reading immersed in old London. The school bases these lessons on evidence suggesting that authentic experiences help create strong writers. Teachers can also control what the students see and use visual VR aids to guide students in their VR environments.



### Chadron State College uses 360 degree cameras to make distance learning more engaging and effective <sup>10</sup>

In order to better connect remote students to campus, Chadron State College invested in the Meeting Owl smart camera system that enabled 360 degree viewing of the classrooms. Online video conferencing methods were leading to poor engagement among remote students as the cameras offered limited visibility and sub-par sound quality, which was riddled with static noise issues. Teachers also complained of the restrictive nature of being positioned in front of cameras impacting their teaching styles and ultimately their effectiveness. By installing the 360 degree cameras, participants could see everything in the classroom without having to manage or move anything. Teachers no longer had to think about adjusting their teaching styles according to the needs of the Audio Video equipment, as the smart camera would track their movements automatically. The smart camera system would automatically follow conversations and display the appropriate speaker. This allowed remote students to understand more accurately who was in the room, which enabled them to be more active participants.



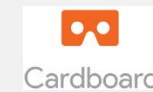
#### Outcomes

Investing in smart 360 degree cameras has improved the classroom experience for remote students and well as the teachers. There has also been an increase in the amount of class participation from the remote students

## VEATIVE

### Veative Learning Simulations <sup>11</sup>

Veative provides immersive content for 3D, virtual and augmented reality technologies. Veative has an ever-growing content library, currently at 650+ modules, that comprise of educational concepts covering areas that include – Physics, Chemistry, Biology, Mathematics, educational tours and language learning. Veative also provides analytics driven feedback to teachers around their immersive technology products.



Google Cardboard <sup>84</sup>, however, is the real game changer for VR in schools. The cardboard and Velcro headsets open up the world of virtual reality for as little as \$7 per device. It is a low cost headset which uses a smartphone for a screen. It is designed for mass accessibility, especially in K-12 classes.

## Key implications

- Immersive technologies can positively impact student engagement which seems to remain high and extend to other non-immersive discussions in the classroom
- The technologies can make virtual experiences available that may otherwise be prevented by distance, geography or other limitations
- Younger students can find it easier to learn through immersive technologies, especially if the study topic is considered difficult

# AI Augmented Learning



## Overview

Artificial Intelligence and machine learning are making an impact on educational tools. AI can drive efficiency, personalisation and can streamline administrative tasks, freeing teachers to spend more time and focus on effective teaching. Several learning platforms are currently using AI to provide learning, assessment and feedback support to students from pre-K to college levels. The AI identifies challenges they are ready for and gaps in learning, and guides students towards learning material that can help. AI has been used to assist educators in grading assessments saving a tremendous amount of time. AI tools in the form of Conversational User Interfaces (CUIs) are also making their way into classrooms. The rapid growth of virtual personal assistants, such as Amazon Alexa, Siri and Google Assistant, is increasing the comfort level of consumers interacting with voice assistants. CUIs enhance engagement and bi-directional interaction for students as they take judgement and social concerns out of the interaction. CUIs have been observed to create meaningful interactions for the student with the digital learning resource.

### Georgia Tech's computer science professor relies on an AI teaching assistant <sup>12</sup>

When overwhelmed by the number of students and inquiries Professor Ashok Goel had to manage, he turned to "Jill Watson", an AI assistant. The objective was to ensure that students get their queries answered and retain interest in the course and didn't drop out. The AI support was conceived using Georgia Tech's Q&A platform in a utilitarian message board format, with questions topics mentioned in a column, each of which opens a threaded conversation. The AI assists the Professor's physics class of 50 students, and the more heavily attended online class as well. The AI takes routine questions such as queries about proper file formats, data usage and the schedule of office hours. The AI was based on IBM Watson.



#### Outcomes

The AI was trained in not only answering questions but also in understanding the context of its interactions with students with 97% accuracy. The students were often unaware that the "Jill Watson" responding to their queries was an AI bot. The AI helped the professor tackle close to 10,000 questions per semester and still ensures a higher percentage of students complete the online MOOC (Massive Open Online Course) they are enrolled in.

### Slackwood Elementary School in New Jersey uses AI to improve math scores for first-grade students <sup>13</sup>

Slackwood Elementary School introduced an AI assistant to help improve performance of first-grade students, a majority of whom were struggling to achieve high test scores. At the beginning of the year, 60 percent of the students score a preliminary benchmark score of 9 out of 48, which is when the school decided to augment teaching with the help of AI assistants. The school introduced a machine-learning based teacher assistant called Happy Numbers into the classroom.



#### Outcomes

After nearly a year of using the AI-augmented program, nearly all the students improved their scores to a 35. The AI-augmented program led the students to transition from memorising answers to understanding the concept of problem-solving.



### WriteToLearn <sup>14</sup>

A web based writing environment that uses Artificial Intelligence to automatically respond to a student's writing in terms of narrative, exposition, description and persuasion. It provides prompts and summaries of texts in order to build reading comprehension, it scores the writing and provides writing advice. WriteToLearn enables teachers to focus more on the content and less on the mechanics and grammar of their students' writing



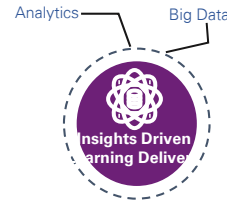
### IBM Watson <sup>15</sup>

IBM Watson education solutions use artificial intelligence algorithms that answer questions posed in natural language. The system enables teachers to monitor student progress during lessons, supports lesson planning and gives advice about what to include based on student needs. It uses a model of the whole learner to generate suggestions on how best to help each student in the classroom, so that students can receive targeted support more quickly. Data-driven insights in identifying gaps for each student and map the gaps to remedial content. Teachers are provided with student performance data, such as improvements over time and student achievements against state standards

## Key implications

- Properly deployed and in the right circumstances, AI solutions could help teachers reduce time spent answering routine queries and to spend more time on teaching
- AI can support automation and the improved analysis of learning needs, again freeing teacher time for more targeted learning interventions

# Insights Driven Education



## Overview

Big data and advanced analytics are generating insights to enable better decisions. Big data describes large data sets that can only be processed and analysed by computers. By gathering and interpreting data from learners, analytics can improve the targeted selection of additional learning content for students.

Not only is data used to personalise the learning experience, it is also being used in combination with other data points to provide earlier identification of welfare intervention indicators or to provide predictive analysis of the propensity to leave school before the completion of year 12. Earlier welfare interventions can lead to positive outcomes in student health and safety, and improve school completion rates.

Increasingly, data sources from across the education ecosystem are being mined and analysed to understand the effectiveness of pedagogical approaches or to determine the effectiveness of programs and initiatives. Predictive analytics may improve the operation of the system as a whole, for example, a predictive maintenance schedule across an asset base of thousands of buildings and tens of thousands of learning spaces could redirect maintenance expenditure to new learning initiatives.

### Arizona State University (ASU) uses predictive analytics to improve student performance <sup>16</sup>

ASU's instructors, advisors and students are benefitting from the usage of analytics, through early-alert systems that aggregate and analyse data from multiple sources which include – gradebooks, learning management systems, student information systems, student registration and background data, etc. These systems based on historical data and prediction algorithms, predict the impact of student activity on student performance. Advisors get notified when students get off-track and are encouraged to intervene. This tool, known as eAdvisor also uses data to make registration suggestions to students and advisors



### Spokane Public School uses data analytics to identify and pre-emptively support potential at-risk students <sup>17</sup>

As a result of recent big data and analytics initiatives, the school can readily identify at-risk students in order to improve graduation rates and by acting as an early-warning system. The school's IT team built a data warehouse by integrating data from several separate applications. The central repository held data from various sources, including the student information system. Utilising Tableau Software's analytics tool, the team designed a dashboard to generate a variety of visualisations of the data sets based on the District's needs. They then developed a set of indicators of at-risk students including grades, attendance, behaviour and assessment results. The analytics tool creates a profile of every student and updates the profile daily. The real-time data shows when students are at risk and allows for timely intervention in providing academic assistance.



### Outcomes

As a result of the big data and analytics initiatives, in three years, the District's graduation rate has risen nearly 8 percent, from 76.6% to 84.5%

### Schoolzilla <sup>18</sup>



Schoolzilla allows educators to connect and clean various data sources into intuitive, actionable visualisations. Once the data is connected, Schoolzilla creates customisable data dashboards enabling educators to focus on their key performance indicators. Schoolzilla helps educators benchmark their school's performance relative other schools



### Saviant Student Analytics Platform (SSAP) <sup>19</sup>

SSAP helps schools identify key performance indicators to predict student performance and improve academic performance. SSAP provides a range of analytical and predictive capabilities that enable universities and schools to extract insights on current academic performance to intervene and provide support when necessary. The dashboards offered provide an integrated view of assessment scores, grades, attendance records and comparative analysis to identify drop out possibilities

## Key implications

- Making data available for analysis from across the education ecosystem can improve longitudinal understanding of pedagogical practice and ecosystem performance
- Data and analytics can improve student learning outcomes and flag cases for early welfare intervention

# Learning Gamification

## Overview

Gamification refers to the introduction of game-like elements such as point scoring, progression through levels, competitions, social recognition and leader boards, into non-game situations. Gamification in learning systems and content has been growing in popularity as an effective method of motivating teaching and learning in schools. It can encourage learner autonomy and self-direction while engaging learners in content and context. Gamification works by acting on the following aspects of self-determination <sup>20</sup> needs:

- **Learner autonomy** – Gamification activities have a great degree of self-initiated activities that elicit powerful internal motivations
- **Learning competence/mastery** – Through points, leader boards, badges and trophies, gamification effectively drives course/lesson progression and enhances intrinsic motivation for the activity
- **Relatedness/connectedness** – By enabling instant feedback, gamification can drive the feelings of connectedness necessary for internal motivation

Besides the introduction of game-like elements in education, the usage of game-based learning through platforms that resemble computer games is also a popular approach for driving engagement and learning outcomes.

### Massachusetts Institute of Technology's Scratch is a widely used gamified program to introduce school students to computer science <sup>21</sup>

Scratch is a visual programming language developed by the MIT to enable students, teachers and parents to create games and multimedia videos to serve as the stepping stone to computer programming. It enables an easy understanding of computer programming logic without needing to learn a specific programming language. The program lets users drag blocks (that represent programming functions) and attach them to other blocks to represent strings of code. Each type of function is given a certain shape, and can only be placed inside or below blocks that will accommodate it. It introduces users to the core concepts behind programming and code construction and gain an intuitive grasp of the mechanisms of event-driven programming languages.

#### Outcomes

Scratch has been widely used since its release in 2005. Many schools have used it as part of their introductory courses on computer science. Its application for basic educational needs is widely acknowledged. The success of Scratch led to the creation of the next iteration called "ScratchJr", designed specifically for students aged 5-7.

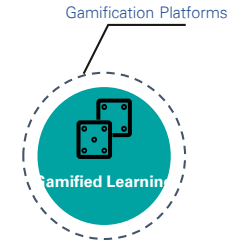


### Portugal's PaRK International School uses game-based learning to raise student engagement and achievement <sup>22</sup>

The school aims to make its students more collaborative and wants to turn them into agile learners interacting with the global society to make an impact. The school introduced Minecraft: Education Edition to provide an engaging and an immersive environment in subjects across the curriculum. Subjects being taught using Minecraft include – math, English, science, arts and biology. The school has a 1-to-1 device program to ensure a tablet with each student. In 2015, students used Minecraft to recreate the geography of Portugal in six months. As part of the "Calvario Project", students used blueprints and architectural plans to simulate reconstructing public areas of Lisbon and modern urban living. The school also is currently developing a new project that will have students recreate a scale model of the entire city as it was during the Roman times.

#### Outcomes

Teachers have seen an increase in the level of motivation among the students in participating in school activities and projects. They also feel more creative and take on a more positive role in supporting each other. Based on the positive outcome Minecraft has had on learning, teachers are also gaining confidence in introducing other educational technologies in the classroom



### NEO LMS <sup>23</sup>

The NEO learning management solution leverages Gamification to make learning more engaging and interactive. It enables educators to create games where students can earn points and badges for completing tasks during class activities. The educators also have the ability to set up game levels which helps students learn how to achieve goals. The solution also provides leaderboards that let students and teachers view progress, number of points and ranks against learning objectives



### BeeUp <sup>24</sup>

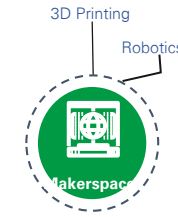
BeeUp is an online platform where students can solve business case studies based on real-world problems. These real-world problems are based on BeeUps company partners. For example, students could develop a business model for an innovative product or a go-to-market strategy for a small to medium business. The platform is open to the public and uses Gamification features to generate and sustain engagement. Students who solve 10 case studies receive a certificate in 'business model innovation' worth 10 European Credit Transfer and Accumulation System points. BeeUp is increasingly being used by high-school teachers where the learning objectives include enhancing cooperation and collaboration, by having groups solve the cases. It uses two points-based systems – one for solving cases and one for cooperation and collaboration. The scores are visualised on a graph which shows student's progress over time. Learners obtain competency levels, which can open up more advanced case studies

## Key implications

- Gamification can make learning more interesting and drive greater learner autonomy
- Organisations are trying a variety of approaches ranging from awarding points/badges during their regular lectures, to using game platforms as an aid to learning



# Maker-Spaces



## Overview

Maker-spaces provide an active learning environment for students to use their creativity to design and make prototypes or real-life models, or to engage in project-based team learning. These spaces can be as simple as a section of a learning space or the library containing an array of maker tools and supplies, or as complex as a fully-fledged lab setup with computers, 3-D printers and laser cutters. Technologies like 3D printing create opportunities for teachers to create visual aids and teach about innovative concepts which the students can experience first-hand. Maker-space movement drives a student-centred learning approach that engages students in classrooms and prepares them for future. At the heart of this movement is the understanding that the most effective way to learn is one where the learners develop their understanding by doing. The key to the success of the maker-space is the shift to a learning environment that enables exploration, creativity, innovation and collaboration with hands-on materials and real-world problems.

### Spring Hill School District in Arkansas adopts maker-spaces to drive hands-on learning <sup>25</sup>

The Spring Hill School District in Arkansas implemented maker-space in schools to integrate hands-on learning through experimentation, building and collaboration. Students and teachers created cardboard robots and used 3D printers to build wearable computers. Spring Hill maker-space serves almost 600 students and incorporates traditional computers and laptops, along with new technologies such as – tablets and robotics. The maker-space leverages programs such as MIT App Inventor, Sphero's Ollie programmable robot, LittleBits electronic building blocks, a Makey Makey invention kit, Parrot's Jumping Drones and Google Cardboard virtual reality tools.



#### Outcomes

One of the main benefits of maker-spaces has been an increase in student motivation to engage in problem solving. Spring Hill touches about 100 to 150 students daily as a result of the integration of maker-space technologies into course offerings, ranging from high school physics and computer programming to elementary social studies.

### St Aidan's Anglican Girls' School in Corinda, Queensland transformed the school library into a maker-space <sup>26</sup>

The school to introduce the concept of hands-on learning to its students, decided to convert the library into a marker-space environment. The school began with simple, low-tech projects to kick-start the maker spirit among the students, such as using copper tape to make circuits and light-up greeting cards. The school now runs more advanced projects with specific resources like Lego Mindstorm robots, 3D doodler pens and 3D printing, which involved printing 3D Minecraft avatars. Year 3 students used the maker-space to construct their own laptop. The maker-space has also taken up the task of introducing computer coding to the students. Students have used the maker-space to build a Piper Computer (see image) using a computer assembly kit and play Minecraft on it. The students are also in the process of building an XY plotter. Students have started bringing their own materials and equipment, and have started to work on their own projects and frequently invite others to collaborate in the building activity. This has led to an environment that is stress-free, is inviting and fosters creativity.



### Piper Computer Kit <sup>27</sup>

The Piper Computer Kit teaches budding makers and future engineers about computers and other electronic hardware gadgets through the process of engaging them in hands-on building and coding. Through the process of building things, taking them apart and experimentation, the Piper Computer Kit fosters confidence building experiences that spark curiosity and inspire students to learn more.



### Birdbrain technologies – Hummingbird Robotics Kit <sup>28</sup>

The robotics kit is a programmable robotic kit for grades 4-12 students. It aims to teach students a wide variety of subjects, ranging from engineering, to art and English by building and programming robots. The kit contains controllers, motors, LEDs, adapters and different sensors. Students can use the materials in the kit to make their own bots. This enables the students to develop an interest in engineering and science.

## Key implications

- Maker-spaces drive hands-on learning and are being used by schools to teach students by helping them explore real-world problems
- The use of maker-spaces is believed to drive collaboration, team-work, to assist in thinking creatively, problem solving, and in intrinsically teaching digital literacy. It develops computer-aided design and fabrication skills, engineering concepts and elements of the material sciences. It has been shown to improve the uptake of STEM subjects and courses.

# Learning Space

## Overview

Schools are transforming learning places by providing digital devices to students in collaboration-friendly spaces. Traditional learning spaces are being transformed in order to integrate technologies and deliver agile classroom environments. Classroom spaces are being reconfigured to facilitate better proximity to the teacher, such as allowing the teacher to move around the room more freely while presenting. Teachers can more readily view student screens and launch content directly, and provide instant feedback and course correction to students in need. These innovative learning environments provide the means to incorporate more agile learning methodologies by facilitating educators and students to work in groups, and to monitor and control progress in shorter feedback cycles in a more iterative manner. Key components of these redesigned learning spaces are:

- **1-to-1 ratio approach** – Aims to provide each student with a digital device such as a laptop or tablet
- **Classroom Set of Devices** – Digital equipment such as Smartboards, pods of Smartdesks, VR equipment, Aruba Wi-fi technology (that track students as they move) and to drive digital interactions within the classrooms
- **Agile teaching approaches** – Involve learning in quick sprints, learn in squads (collaboration and teamwork) and focussing on continuous improvement in an iterative manner

### Cadoxton Primary School reinvented it's classrooms to promote a more independent way of learning <sup>29</sup>

The objective of the new learning spaces was to provide children with a more dynamic learning environment to inspire them to think creatively, communicate well and be able to solve problems. The scope of the learning space redesign included – having 8 computers at the back of each classroom to be used in each session, having ergonomically comfortable seating for children to work with using iPads/iPods, usage of coloured lighting to create different moods to signal the introduction of new activities or challenges, a writing and reading zone with tables arranged to enable group and individual activities, a writing wall to allow ideas to be explored and have children to share the ideas, a puzzle table at the centre of the room to enable the children to work practically and collaboratively and a TV screen with Apple TV to encourage children to collaborate and share their work.

#### Outcomes

The increase in space resulting from the removal of traditional classroom furniture enabled the classroom to be more agile in promoting varied learning approaches. Children have been taking more ownership of their learning which has resulted in improvements in both learning outcomes and behaviour. The children of the school have been continuously inventing their own ways of learning as they feel empowered to do so



### Lampton School's learning space of the future was designed by students based on their learning priorities <sup>29</sup>

The students in consultation with experts, managed every aspect of the design of their classroom of the future at Lampton School. The goal was to make learning creative, fun and flexible. Interactive whiteboards in the classrooms were replaced by two screens with projectors to enable easy display of instructions and to enable students to show work. The screen is used to showcase the school's Twitter stream and run news broadcasts as well. The learning space has 20 iPads and an equal number of Fizzbooks which are basic touchscreen laptops, along with six iMac computers. These digital devices enable students to work at their own pace, on differentiated work streams planned by their teachers and shared in advances of the lessons. Students are allowed to use mobile phones in the learning spaces as well, which are used to record the learning taking place in the classroom. The learning spaces use colour themes by using LED lights that change colour and coloured furniture. To keep students constantly involved, certain elements of the learning space are regularly refreshed and students are encouraged to manage the process.



### G Suite for Education <sup>31</sup>

Google's suite of tools enable educators to collaborate anytime and anywhere, streamline administrative tasks without disrupting current workflows. The free solution covers a wide array of educational needs of a modern classroom. The suite of tools enables the creation of classes, distribution of assignments, quizzes and the collection of feedback. Educators can easily administer the learning environment by being able to add students, manage devices, manage tasks, set reminders and configure security and settings. The suite also has collaboration tools that enables educators to co-edit documents in real-time. The suite enables communication beyond the classroom through emails and video conferencing



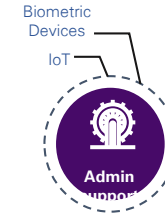
### PowerSchool Unified Classroom Learning <sup>32</sup>

PowerSchool is an integrated, easy-to-use, cloud-based learning management and classroom collaboration solution. The solution helps educators simplify instructions and save time by providing a unified space for all learning resources. It enables educators to create embedded, multimedia rich customisable, interactive lessons quickly. Educators can integrate personalised project-based learning with an online collaboration space. Educators can build class pages for storing information on lessons, activities and assignments. The solutions makes it easy for educators to embrace cloud-based learning, flip their lessons and promote paper-less classrooms

## Key implications

- Digital technologies in classrooms such as interactive displays, smart devices and tablets, video conferencing and chat and screen casting capabilities require re-thinking optimal classroom design
- Presence of digital technologies enable agile teaching approaches, where better classroom visibility and the ability to give instantaneous feedback drive continuous improvement

# Administration Support



## Overview

Schools often have several time-consuming administrative functions which include staff management and scheduling, facilities management, managing inventory, event coordination and more. The management of these tasks on a daily basis can overburden both teaching and administrative staff, result in higher operating expenses, as well as cause opportunity costs in lost teaching time. Automating administrative tasks can save time, effort and money for schools. Some popular automation use-cases include:

- Back office automation – Consolidating and simplifying resource access (systems, assets, and tools), finance management, operations automation (vendor management, event management, inventory and asset management, etc.), maintenance and IT support
- Digitisation of paper-based information and processes
- Building automation – including energy, heating, ventilation and air conditioning management, waste management, lighting, etc.

## Back-office integration and automation

The diverse array of tasks and processes involved in running a school can stretch administration staff. Simplifying and automating the resulting administrative complexities around back-office functions such as financial management, HR, asset management, timetable management, procurement functions and vendor management can improve efficiencies. Some schools leverage Enterprise Resource Planning (ERP) solutions to integrate and manage these processes to drive operational efficiencies. Cloud-based ERP systems can provide flexibility of configuration and scalability, as well as providing better practice processes and end-to-end system insights.

### Fargo School District turns to ERP to streamline administrative processes <sup>72</sup>

The Fargo and West Fargo school districts realised that their back-office operations were costly and difficult to manage, as a result of rapid growth in the number of students and teachers. The districts had found it difficult to keep up with tasks spanning financial management, HR and payroll. The schools were looking for a single system that could integrate these business functions, while also handling school-specific functions such as teacher contract management to drive efficiencies in school administration. The school districts adopted the Microsoft Dynamics GP system which provided multiple management module such as – teacher contract management and payroll, financial management and state reporting along with time keeping and substitute tracking.



### Outcomes

The Fargo and West Fargo public school district not benefit from an integrated ERP system tailored to the specific needs of school administration. The districts have been able to significantly streamline back-office operations while supporting rapid growth. Managing back-office operations is now done with a few-clicks, and manual data-entry has been largely eliminated.

## Paperless Processes

From printing and stapling together handouts and assessments, to filing forms and generating letters, paperwork can consume a lot of time for teachers and administration teams. Digital tools such as communication platforms and business process and workflow engines can support information handling more efficiently and result in higher productivity and less error. Reducing the usage of paper and dependence on manual processes helps educational organisations save costs and time and drives eco-friendly practices.

### City of London School for Girls (CLSG) uses an integrated school management system to digitise processes and reduce staff workload <sup>33</sup>

The school integrated multiple ICT systems that were impacting teachers, pupils and staff onto a centralised information management system. The school created a new interface called “The Portal” which was used for data access, ensuring data consistency and ease of access. The move saved the staff from manual data entry and retrieval tasks and laid the grounds for a “cashless catering system” along with a school wide biometrics system. The school has the vision of moving “everything” online



### Microsoft Azure <sup>85</sup>

Azure for education lets schools build, deploy and manage applications with a comprehensive set of cloud services. Azure enables a Platform-as-a-service model to be leveraged by schools. Moving services to Azure can reduce the cost of running and maintaining services.



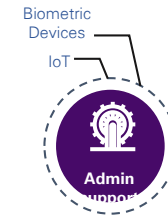
### CareMonkey – digital platform for school forms<sup>73</sup>

CareMonkey is a web and smart phone (app) based solution that helps schools and districts eliminate school forms, enabling paperless processes. It has group message features and automated notification dispatch capabilities as well. The solution also has cyber security features to keep information secure

## Key implications

- Implementation of IT solutions such as ERP system help save administrative time by simplifying or automating data entry and management tasks. They integrate school systems as provide an end-to-end view of administrative processes
- Cloud-based ERP systems can offer agility and scalability compared to their on premise counterparts
- Moving to paperless meets demands for digital interactions by the citizenry, reduces costs, improves efficiency and reduces errors.

# Administration Support (contd.)



## Biometric identity systems

Identity events leverage digital biometric devices that automate many school administration and support processes. Some popular examples include – ensuring academic integrity for monitoring student behaviour during assessments, taking attendance through fingerprint and iris scanners, controlling access to facilities to ensure safety, biometric student registration and cashless fingerprint lunch catering.

### Jarrow School uses a low maintenance cashless biometric catering system to make lunch catering seamless<sup>33</sup>

The school introduced a cashless biometric catering system to reduce pressure on kitchen and support staff and to manage lunch queues better. The system called the FasTrak solution, was integrated with an online parent payment solution and with contactless cards that the teachers used in order to not disrupt or disturb the cashless catering. Students can now scan their fingerprints and the system automatically recognises the student, and drives the catering process forward seamlessly.



#### Outcomes

The system had the entire student body signed up in just a few hours. The process of adding and removing students from the program is also quick and easy. The integration of the catering system with online payments improved the school's canteen experience, with queues getting reduced and the catering staff finding it easier to manage their workload

## Building Automation

Keeping operational expenses down to be able to utilise budgets optimally is a key concern for educational institutions. With assets spread over large campuses, keeping energy and waste costs down is a difficult task for schools. Special environmental needs of laboratories and research facilities add to the complexity of energy management. Hence energy and waste management becomes a key focus area for educational institutes as part of their building automation initiatives. Building Energy Management Systems (BEMS) provide organisations centralised control over their lighting and HVAC equipment. Building automation also provides for a better atmosphere for learning. Poor air quality, inefficiently controlled heating and ventilation systems impairs the learning ability of school-children. Building automation systems focus on making the learning spaces comfortable to make them conducive for effective learning. Many educational institutions are also focusing on the smart campus concept, which entails drastically reducing greenhouse gas emissions and producing their own energy using renewable sources. Leveraging today's innovative technologies around building automation, organisations are focusing on becoming healthier and more productive while driving learning outcomes in a better more efficient manner.

### Gisèle-Lalonde Secondary School in Orleans uses IoT to reduce energy consumption and improve student performance<sup>34</sup>

The school utilised Internet of Things (IoT) technologies for reducing energy consumption and improving student performance by creating a safer, more comfortable and highly productive learning environment for students. The school achieved this objective by – a) using smart meters for efficient water and gas management, b) benchmarking energy consumption per student, c) actively measuring and tracking carbon dioxide levels and d) tracking building occupancy in real time. The school used IoT for exerting a better control over its current building and automation systems (BASs) with inexpensive utility meters, people counters an IoT gateway and other related sensors which were installed at select places within the campus.



#### Outcomes

By using a centralised dashboard, the school is able to monitor all the data coming in from sensors in one place. Getting access to all the relevant data in one place lets building managers and school administrators ensure that student and staff are comfortable, without having to invest a lot of time and effort.



### BioStore's FasTrak Cashless Catering<sup>35</sup>

FasTrak's Cashless Catering facilities allows schools or businesses to go completely cashless. Staff or students can collect their meal for the day with a simple & quick authentication from an ID smart card or biometric reader. Meals can also be pre-ordered using an online account that can be topped-up



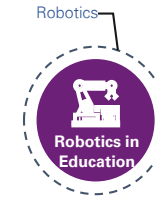
### Alcatel Lucent Enterprise for Schools (ALE)<sup>86</sup>

ALE solutions drive building automation for schools using IoT technologies. The ALE network provides anywhere Wi-Fi connectivity, improves campus operations with IoT systems and provides cybersecurity features as well.

## Key implications

- Schools can use biometric identity systems to automate administration processes such as – student registration, attendance, exam monitoring, lunch catering process, etc. saving time for teaching as well as admin staff, and ensuring ease of usage for students
- By automating building energy and facilities management, schools can save administrative staff time. Such IoT based systems can perform remote monitoring, asset management, workflow automation and predictive maintenance tasks. Administrative staff can control a wide array of systems using dashboards that provide relevant information, fed-from energy and facilities management IoT equipment

# Robotics



## Overview

Robotics provides students with an engaging learning platform that incorporates many fundamental STEM concepts and makes learning STEM subjects enjoyable. Participating in project based robotics learning models exposes students to STEM pathways that enables them to learn:

- Fundamentals of engineering and technology, including the science of mechanical systems, materials, electronics and electrical systems
- Programming concepts and applied mathematics

Programming concepts taught in traditional ways can be hard for students to grasp and hence may not generate a lot of interest. Robotics however, makes coding concepts easy to grasp by having involving tangible outcomes in learning. Programming robots makes students learn from what they see and experience, enabling them to learn the skills needed for precise and accurate instruction delivery through compute programming. Teaching robotics in schools gives educators the opportunity of teaching STEM subjects more effectively, and can assist address the growing demand for STEM skills in the economy.

### Winnetka Public Schools District 36 elementary school uses robotics to get students interested in STEM<sup>37</sup>



The school uses a game of Robot Turtles to teach young students the step-by-step nature of coding. The school has been ramping up the usage of robotics along with the development of a curriculum that will prepare students for a future that is increasingly focused on STEM. The school started with robotics courses by conducting pilot courses and on getting a positive feedback, decided to scale up and introduce robotics for all students. Each student has access to robotics through maker space labs which are present in each elementary school in the district. The school exposes students progressively to more complicated robots and coding opportunities. The school introduces students to Kibo after Robot Turtles, which requires students to snap the right blocks together to have the robot perform the desired action. Thereafter, the students in higher grades get exposed to block programming in conjunction with more complex robots

### Outcomes

The school hopes to have their current students move onto careers in STEM areas. Some of the recent trends have been in increasing gender diversity, with more female students participating and enrolling in STEM subjects

### Altona Primary School teaching students robotics<sup>38</sup>

The Victorian Digital Technologies curriculum enables students to become creative and confident developers of digital solutions through interactions of information systems and ways to problem solve. Students at Altona Primary School are taught the process of developing software at different year levels. Most of the students work through robotic problems to gain skills in coding. Different year levels are provided with different robotic kits. Prep students use the Dot & Dash robots, Grade 3 use Lego WeDo kits, Grade 5 Lego Mindstorm NXT sets and Grade 6 use Lego Mindstorm NXT and EV3. Each of these kits will add complexity and difficulty to the process of coding and interacting. Students are required to learn about different mechanisms and sensors, such as pulleys, motion sensors, lights and ultrasonic sensors, and code the robots to utilise these systems to complete tasks and challenges.



## Sphero Bolt <sup>39</sup>

The Sphero Bolt is created to allow students at different age groups to develop and test with the Bolt using a computer or tablet. There are three main categories of students:

Beginners – instead of coding, students can draw paths for the Bolt to follow

Intermediate – Scratch blocks are used to generate instructions

Advanced – JavaScript are used to code instructions and can use the Bolt's on-board sensors to gain information similar to IoT sensors.



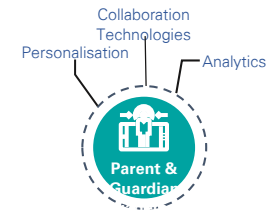
## Noisolation AV1 <sup>40</sup>

Noisolation AV1 allows students to attend class when they cannot physically be there. Students can still take part in classes by connecting through their phone or tablet app. AV1 is targeted at children with long-term and chronic illness, students have the ability to collaborate with their classmates.

## Key implications

- Robotics help schools generate interest in the STEM subjects
- Market offerings are increasingly diverse with varying levels of robot complexity for students of different age groups. Simpler kits are similar to Lego blocks while more complex ones require guidance and careful handling

# Parent & Guardian Engagement



## Overview

Parents and guardians increasingly desire more regular and focussed learning progress updates of their children, something that is more difficult to achieve in face-to-face meetings with teachers at checkpoints. Digital solutions are taking a larger role in allowing parents and guardians to stay abreast of their child's academic or behavioural progress. These tools include mobile text messages, video summaries, mobile apps and digital dashboards that give parents a deeper look into their child's performance and experience in the classroom. These tools also play an important role in forging a tighter relationship between school and the parent & guardian communities. They can also play a vital role in updating parents in cases of emergency. Some of the other notifications that can be triggered through such systems include fee payments, examination and class schedules, excursion dates, performance and grade-related intervention needs and attendance status.

### San Francisco Unified School District (SFUSD) uses a simple text messaging program to give bite-sized tips to kindergarten parents <sup>41</sup>

SFUSD ran a pilot of a texting program developed by researchers at Stanford that supports parents in their efforts to teach their children their ABCs, and prepare them for kindergarten. The program called READY4K!, sends weekly cell phone texts to parents of pre-schoolers to give them useful and specific actions related to developing early literacy skills. SFUSD needed a solution to boost family engagement and READY4K provided just that. The increase in parental activity was aimed to also drive learning gains for children, as the effects of the messages trickled down to the children. Suggested actions in a text message are as simple as "Say two words to your child that start with the same sound, like happy and healthy". Another set of messages would be aimed at addressing several literacy skills, parents get tips to make the most of bath time - by pointing letters on a shampoo bottle and asking the child to name those letters and the sounds. The texting program was used as it was easily scalable, inexpensive to administer and widely accessible.



#### Outcomes

The costs of the program were relatively minimal – at \$1 spent per participating family and these were likely to come down owing to an increase in participation. Participating parents had a higher frequency of engagement in home literacy activities, and also showed higher levels of school engagement

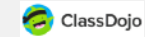
### Ascham School built a portal to deliver a personalised experience to parents to enhance their involvement in the learning process<sup>42</sup>



The school identified opportunities for improvements based on parent and community needs around tracking student performance and school behaviour. The school created a dashboard to users to provide an interactive online portal for families to get relevant information. The "events on my calendar" function on the dashboard ensures relevant events are not missed by parents. The parents can interact with the calendar by adding more details to events. Parents can also customise the dashboard to select what type of information they want to receive and how they want to view it. For example, parents can choose to receive information and alerts through emails as well, along with selecting the information items they'd want in the emails. The dashboard is also integrated with the School management system to provide a holistic view to all users (teachers, parents, school admins, etc.). The school also uses the dashboard to notify the community of important news regarding school activities on the digital bulletin board.

#### Outcomes

The dashboard provides the parents and other users a single integrated platform for all communication and information. The dashboard provides ease of access to personalised dashboards and reduces the administration overhead.



### Class Dojo <sup>43</sup>

The text-based app allows educators to update parents on student behaviours, both positive and negative. The app allows educators to send messages in 35 languages. Parents also have access to a timeline of pictures and videos about their child's experiences.



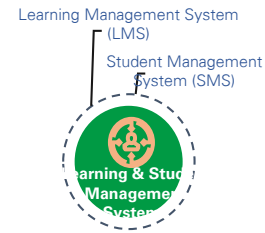
### Elcom engagement platform <sup>44</sup>

The Elcom Engagement Platform is a tool to enable schools to engage with a wider community of users that may include internal as well external stakeholders. It provides a central point of communication and information for parents, students and teachers. It provides access to information such as – personalised attendance records, timetables, exams and assessment results and rosters, to news and upcoming events

## Key implications

- Parents & guardians are increasingly expecting more rapid and convenient communication and interaction with their education service providers
- Digital technologies can offer these advantages, improving interaction and communication, while decreasing administrative cost

# Learning & Student Management



## Overview

Learning Management Systems (LMS) are software-based platforms that help educators and school administrators with the management, delivery and tracking of learning progress in their classes. Smart LMSs use data analytics to recommend personalised instructional plans or a personalised learning pathway for each student. A smart LMS can be used to support modern learning delivery such as flipped classrooms, where lesson content is consumed prior to the class and then discussed in class, flexible learning and distance learning (focus on online content). Advanced LMSs should be able to integrate with Student Management Systems (SMS) to allow learning progress tracking against student profile information, and should also incorporate features around plagiarism prevention, management of e-portfolios, lesson recording and other digital aspects gaining popularity.

### Glenvale School uses a modern LMS that provides full curriculum support to their virtual classroom <sup>45</sup>



The school's main priority for using a modern LMS was usability for teachers and students as well as full curriculum coverage, easy resource sharing and parent access. The school was also interested in using the LMS for providing full curriculum support to their virtual classroom and self-directed learning framework. The school uses the CANVAS LMS. Parents for the first time have access to the work their children are doing at school, and receive timely feedback on their performance and progress from teachers. The LMS has been integrated with Office 365 to enhance scalability and usability. The school also undertook an extensive training activity to ensure students and staff were comfortable with the system.

#### Outcomes

The LMS system has been found to make learning management easy for teachers, students and parents, and has made resource access and sharing easy. Most teachers have adopted the LMS well and have set up all courses online.

### University of Groningen adopts a modern LMS to become more student centric <sup>46</sup>



The University was looking to enhance the overall online student experience to support international growth, personalise the students' learning experience, develop an efficient feedback process and integrating systems to create institutional efficiencies. The university adopted **Blackboard** LMS to move to a virtual learning environment. This has enabled the University to create a more personalised environment without having to worry about managing technology. The LMS provides students with a unified environment to manage their education experience which has information around – their grades, library loans, schedules, available workspaces, balance for student cards and other more personalised information items. Using analytics from the LMS, the University has also developed an early warning system to highlight student performance issues and to generate a graphical representation of their progress.

#### Outcomes

Since the implementation of the LMS system, the number of users has grown from 1,000 to 61,000 per day.

## Blackboard

### Blackboard <sup>47</sup>

The LMS claims to be fully responsive as can be rendered on multiple devices – smart phones, tablets ,etc. The LMS also provides actionable insights to drive personalised interactions with students. The LMS also has open access features and is based on a SaaS model.



### D2L's Brightspace <sup>48</sup>

Brightspace LMS features a content library and a grade repository. The LMS allows teachers and administrators to analyse student progress as well personalised student learning. It also includes an analytics suite called Brightspace insights which features a predictive analytics capability, to identify trends in student behaviour and help educators make timely interventions. The LMS also includes a data platform, which acts as a centralised data repository for aggregating additional data points, collected through integrations with other systems.

## Key implications

- Integrated LMS and SMS systems may now deliver advanced analytics capabilities as well and help manage the entire student lifecycle, in a more efficient way
- Cloud technologies provide greater scalability and potential for cost reduction

# Collaboration and Communication



## Overview

Digital technologies are rapidly changing how students collaborate and communicate. With the focus on project-based learning, students are increasingly working in teams to tackle complex concepts. Such learning needs not only require soft skills around teamwork to make students effective, but also require access to digital tools that drive the collaboration and communication needed to work effectively. More schools are now standardising collaboration spaces and tools as part of the learning environment to aid students in their learning needs and to lay the foundations of an innovation mindset. Teachers are also increasingly expected to collaborate effectively for their own professional development and to contribute to professional communities of practice. Collaboration and communication tools are becoming ubiquitous in modern working and learning environments. Examples include:

- Digital tools such as Microsoft Office 365 cloud-based platform and co-authoring tools
- Google's suite of applications
- Skype
- Microsoft Teams

### Emery Unified School District in California is invested in driving collaboration based learning <sup>49</sup>

The district has not just invested in technology but has also designed the school to foster collaboration based learning. The district's \$90 million joint-use facility will be used to drive project based learning among its students. The district boosted its network with Brocade wireless switches and latest access points. Around 700 students are being provided with their own Lenovo PC tablets. The district also adopted Google suite and other cloud-based collaborative applications to promote collaboration and engagement. Some of the other collaboration focused applications adopted include – Prodigy and Front Row. The district also outfitted each room with 82-inch planar touch screens running collaboration software applications. These can also be used to stream high-definition videos to enable the class to view online resources.



### Outcomes

The collaboration approaches followed by the district have enabled easy learning outcomes for students and have resulted in an increased ease of using digital tools among teachers and students. The district's network and collaborative tools are also being leveraged to boost online professional development and mentoring opportunities for teachers.

### Greenville City Schools use digital collaboration tools to drive learning outcomes <sup>50</sup>

With the initiative of providing each student with their own HP stream device, the school kick-started a digital collaboration approach to their teaching methods. These devices provided a foundation to the students to collaborate and communicate as part of their everyday learning experience. The district provides a single sign-on to both Google-Suite and Microsoft's Office 365 cloud-based platforms, along with the school's learning management system (LMS). Students use tablets to peer-review each other's work by entering into a collaboration space in Microsoft OneNote, which also has a teacher-led forum and a discussion blog. This enables the students to post their work within their own online notebook and get quick but private feedback from the teacher.



### Skype <sup>51</sup>

Skype is a video conferencing application allowing students to collaborate remotely and with students from other schools. Skype offers virtual field trips, lesson and guest speakers to teach about specific topics.



### Google G-Suite <sup>52</sup>

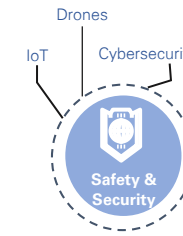
Google enables collaboration through integrated email, creation and storage of documents, spreadsheets and presentations. Students can work collaboratively together on a presentation in real-time either within the classroom or for homework. Using Google Classroom students can be provided with learning activities directly by teachers.

## Key implications

- Collaboration tools can enable more effective team-based learning, developing real-world skills in students
- Teachers are using collaboration tools to develop and engage in communities of practice and participate in continuous professional development



# Safety and Security



## Overview

To address safety concerns, schools need to implement solutions that work together to keep students safe, without causing the educational environments to become less conducive to student success. Educational institutions must invest in comprehensive, integrated and automated security networks encompassing physical as well as cyber security systems

**Physical security** – Installation of IoT based network video recording (NVR) systems, using computer vision for access control and early warning, which can use facial recognition, drone and kiosk surveillance and IoT sensors for detecting environmental anomalies (toxic gas leaks, hazardous water quality, air pollution, etc.)

**Cyber security & safety** – Involves adopting security and privacy policies that enable faculty, staff and students as well as parents to control what personal data is collected and the legal grounds for processing the data. Evaluation of practices and methods for collecting and managing data is done periodically and initiatives for mitigating data breach/cyber attacks (ransomware, botnets, hacking ,etc.) and protecting student privacy are enforced. Online safety assurance includes hard constraints such as monitoring of online activity, and soft constraints such as guidance on proper online behaviour and how to be safe online

## Schools in China introduce smart uniforms to monitor students and track their movements <sup>53</sup>

Eleven schools in the Guizhou province have introduced uniforms that have tracking chips to monitor students' whereabouts. Skipping classes triggers an alarm to notify both teachers and parents of the student's absence and an automatic voice alarm is activated if the student leaves school without permission. An alarm will also sound if a student falls asleep in class. The chip can be tracked through GPS which enable the tracking of student movements even once they have left the school premises. Facial recognition technology ensures that each uniform is worn by its correct owner.



### Outcomes

The initiative has raised concerns around the right to privacy, the company manufacturing the smart uniforms claims that the intent is not to track students all the time, only when a student is missing or skips class. The uniforms are claimed to focus on safety issues. Schools have also claimed to have seen an increase in attendance after the introduction of these uniforms

## Lockport City schools use facial recognition to ensure safety on school campuses <sup>54</sup>

The schools are in the process of installing a sophisticated new surveillance system that uses facial recognition by scanning the faces of visitors and looking for matches in the school's security database. The capabilities of the system go beyond facial recognition by being able to flag guns that might appear on camera footage. The school has invested in the system in the wake of a series of mass shootings in schools across the US. The system feeds from a network of high-quality cameras that scan visitors for matches against data from the school's as well as law enforcement databases, to send an alert to the control room in case there is a match. The idea is to get an extra few seconds of warning when an unwanted person arrives on campus.



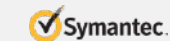
### Outcomes

The school district has secured a \$ 4 million funding and is installing a network of 417 cameras, with the network covering six elementary schools, one middle school, one high school and an administrative building



## VigilAir <sup>55</sup>

New Zealand company VigilAir has launched semi-autonomous aerial surveillance drones meant to act as first-response guards of the future. When not flying, the drones rest in an enclosure – dubbed a nest, located on the site. This technology is suitable for monitoring sites such as – schools, colleges, industrial parks, hospitals, etc. When alerted by an alarm sensor trigger, a drone will be dispatched to the site to investigate and record high-definition video that will be live steamed to whoever will be monitoring the situation. The drone can also house infrared cameras.



## Symantec Endpoint protection Academic edition <sup>56</sup>

The cybersecurity solution enables academic institutions to provide endpoint protection to their faculty, labs and students. The solution is aimed at stopping ransomware, zero-day threats and other sophisticated attacks using advanced machine learning, behaviour analysis and application controls. The system incorporates – an Antivirus, firewall and intrusion prevention, application and device control, system lockdown features, reputation analysis tools (determines safety of files on the cloud) and a host integrity tool

## Key implications

- Cybersecurity measures are of high importance in the school environment, to protect students from inappropriate or dangerous content, and to ensure the safety of children's personal information
- Physical security technologies are becoming more advanced and quicker to deploy

# Case Studies



# High Tech High San Diego

An innovative school model that drives an alternative education style derived from its design principles and focus on project based, experiential learning

## Summary

High Tech High (HTH) was developed by a coalition of San Diego civic leaders and educators in September 2000 as a small public charter school. HTH has now evolved into an integrated network of fourteen charter schools serving approximately 5,350 students in grades K-12<sup>57</sup>. HTH includes a comprehensive adult learning environment with a teacher credentialing program and a graduate school of education, which offers professional development opportunities serving national and international educators.<sup>58</sup>

## Problem statement

HTH wanted to drive student interest in STEM subjects by using an experiential, project based approach to education and by driving meaningful learning among the students. To achieve its goals, HTH has developed an approach which is guided by four connected design principles – equity, Personalisation, authentic work and collaborative design. These principles ensure that HTH is seen as an inclusive STEM-focused high school.

- Equity – Teachers work to address inequities and help students in reaching their full potential. Schools are kept intentionally diverse and integrated to leverage the value from diversity
- Personalisation – HTH practices a learner centred, inclusive approach that supports and challenges each student. Students pursue their passions through project, and reflect on their learning.
- Authentic Work – HTH projects incorporate inquiry across multiple disciplines to create meaningful work. Students leverage fieldwork, community service, internship and outside expert consultations to add meaning to their work
- Collaboration Design – HTH teachers collaborate to design curriculum and projects, lead professional development, and participate in hiring, while seeking student feedback in each area

HTH's leading practice is the implementation of Personalisation, adult world connection and common intellectual mission

## Methodology and technologies deployed

The school supports learning based on its principles by leveraging the following digital technologies<sup>70</sup>:

- Makerspace – Students and teachers use a makerspace with animation and modelling capabilities, and fabrication equipment. Students utilise makerspaces to complete project based design and fabrication activities.

- Digital portfolios – Each project requires students to create a digital profile for knowledge sharing and evaluation. Review of the portfolio is done as part of the “Presentation of Learning (PoL)” process, which is a formal presentation given by a student to a panel of peers, community members, administration, teachers and parents.
- Flexible learning and digital learning spaces – Technology is integrated into all courses at HTH. Communication technologies let students and teachers stay in touch outside of the classroom as well through Google collaboration tools, emails, Skype and mobile applications.
- Adaptive learning practices – The school makes regular use of student performance data to inform instructional practices and reports achievement to school staff, students and parents. Staff ensures real-time analysis of daily student performance data to refine the classroom experience and provide regular communication with parents
- Parent and guardian engagement – The school provides parents and guardians with near real-time information about student grades via a web portal which feeds information from the student information system

## Outcomes

- 100 percent of HTH graduates have been admitted to colleges
- Approximately 40 percent of HTH alumni enter math or science fields compared to a national average of 17 percent
- Minority students outperform district and state-wide peers by a wide margin
- HTH facilities have received many design awards, including Educational Design Excellence Awards, prestigious honour awards, and Design Share competitions.



## End outcome

High Tech High has been considered an exemplar model for technology integration into schooling and learning. Its approach has delivered highly effective college admission rates with significant proportions transitioning to STEM courses.

# European Schoolnet

A network of 34 European education ministries aiming to drive digital and ICT usage among European schools

## Summary

European Schoolnet is a network of 34 European Ministries of education, based in Brussels. The organisation aims to bring innovation in teaching and learning to key stakeholders, including various Ministries of Education, schools, teachers, researchers, and industry partners. Since its founding in 1997, the organisation has helped education ministries become more effective in pedagogical use of technology, equipping both teachers and pupils with the skills necessary to be effective in a digital world.<sup>59</sup>

## Problem statement

European Schoolnet's mission is to enable education stakeholders in the transformation of education processes, required to support modern digital societies. European Schoolnet focuses on using the integration of ICT as a force for improvement. The three strategic areas for European Schoolnet are:

- Providing evidence for innovation; providing concrete evidence and data in the area of innovation in education on which to base policy recommendations
- Supporting schools and teachers in their teaching practices
- Partner support; developing and sustaining a network of schools engaged in innovative teaching and learning approaches

## Methodology and technologies deployed

European Schoolnet's focus areas are:

- Digital Citizenship – Includes safe and responsible use of online technology, digital literacy, active and creative digital life, digital skills for jobs and life, coding and computational thinking
- Evidence for Innovation – Includes policy experimentations and driving future classroom related lab projects
- STEM Education – Aims at driving a STEM focus in Europe by driving a STEM Alliance to strengthen links between STEM education and careers, along with supporting the Scientix community for science education in Europe

Some of the projects driven by European Schoolnet with the aim of using digital to drive innovation in European schools are:

- Digital Citizenship projects – European Schoolnet with its focus on Digital Citizenship supports social media literacy, promotion of coding among students, maintaining a core service platform for education, promoting computer science, researching the efficacy of gamification, and driving a program for flexible learning in European schools.

Evidence for Innovation – This program manages a range of projects aimed at supporting digital innovation in schools. It includes:

- “Co-lab” – A lab to support collaboration and learning
- “FCL Regio” – Future Classroom Lab regional network support
- “MENTEP” – for testing tech enhanced pedagogy
- “Task” – for supporting secondary school teachers in developing self-assessment online tools for students
- “Creative Classroom Lab” – for supporting 1:1 tablet classroom scenarios
- “ITEC” – for supporting innovative tech. for engaging classrooms; and
- “Living School Lab” – for supporting schools looking to integrated ICT systems.

## Outcomes

From a network of 18 Ministries of Education in 1997, the European Schoolnet has now grown to 34 members. Two initiatives – the Future Classroom Lab and the European Schoolnet Academy are driving innovation work in schooling to a larger education community in Europe. The evidence-based focus on incorporating digital technologies into education is considered causative of a general increase in the productivity of the education system in Europe. Schoolnet has trained more than 3000 teachers in the Future Classroom Lab project, and has driven online course collaboration to more than 20,000 students.

### End outcome

The European Schoolnet has been focusing on driving digital and ICT adoption among the entire education ecosystem, by driving digital literacy, providing infrastructure and policy support, and promoting STEM education. Its evidence-based innovation approach has been adopted across a network of 34 European education ministries.

# Stanford University d.school

A program within Stanford University open to all Stanford students that provides them the tools and techniques to apply design thinking to real world problems

## Summary

Stanford University's d.school, also known as Hasso Plattner Institute of Design, helps people find their inner creativity and solve real world problems. Their way of working is simple; collaborate with others, work to solve real-world projects and experiment with solutions while taking risks. The school does not grant degrees, but instead it serves as a university-wide hub for innovation where students from engineering, medicine, education, law and social sciences come to take classes together and work on projects.<sup>60</sup>

## Problem statement

d.school wanted to find an efficient way to solve real world problems in a creative manner. The school decided to incorporate design based approaches. d.school is guided by the 8 core abilities which form the basis of their approach to problem solving.<sup>61</sup>

## Methodology and technologies deployed

d.School' is guided by the 8 core abilities which form the basis of their approach to problem solving:

- Navigate Ambiguity – develop solutions with the discomfort of not knowing and ensure ambiguity can be overcome.
- Learn from Others – collaborating and learning from others throughout the process
- Synthesize Information – find insights and develop opportunities within
- Experiment Rapidly – quickly generate ideas
- Move between Concrete and Abstract – understand the stakeholders in order to define the product requirements
- Build and Craft Intentionally – develop produced to a level where feedback can be given
- Communicate Deliberately – capture and form ideas, concepts and learnings
- Design your Design Work – recognize a design problem and bring in the right people and tools.

The school focuses on creating "t-shaped" students with deep set of skills, knowledge and approach to problem solving.

d.School leverages digital technologies for driving collaboration to solve real-world problems, including:

- Digital learning spaces - design thinking allows students to develop skills to solve problems in different ways. The learning space is designed to allow for design thinking sessions to be run and facilitate innovation to grow.
- Rapid prototyping enables students to create different versions of their solutions. d.school is built as a studio and students have access to digital resources such as virtual Reality, collaboration spaces and a maker space to create prototypes.
- Emerging technologies to drive real-world innovation - as new technologies are created, d.school brings in these technologies to allow students to experiment and prototype their ideas<sup>71</sup>. These classes are based on real-world projects and partners to give students an exposure to constraints and environments that teach them to be innovators of the future. The school collaborates with digital organisations for these real-world projects, these organisations include –Mozilla, Visa, Facebook, Procter & Gamble, Kaiser Permanente, Google, Walmart, Electronic Arts and more.

## Outcomes

- Students launch products and services with a focus on impacting the wider community and the world
- Students discover their purpose in life and their skills to solve problems creatively
- Projects have been created to reimagine education on campus at Stanford and how the future may look
- A Legal Design Lab has been set up by a d.school alumni to find solutions in the legal profession sector.

## End outcome

Stanford d.school alumni boast a number of innovative start-ups. They have created a K12 Lab as a catalyst for improving creativity and problem solving in the K-12 sector. Their approach and program is a direct example of preparing students for the jobs of tomorrow.

Jurisdiction-  
based digital  
education  
policies



# Denmark

## Background

Danish policy and law makers recognised a need to improve the educational outcomes of its school students as a result declining academic standards in reading and maths. Student's competencies in Danish, maths and sciences when leaving public school were unimpressive when compared to other nations. Around 15 to 17 percent of students were leaving the public school system with relatively poor skills in reading and maths. The school system appeared to be failing to recognise and support gifted and talented students.<sup>65</sup>

The Danish government responded by focusing on three key priorities:

- Public schools to challenge all students to reach their full potential
- Public schools to lower the significance of social background on academic results
- Trust in schools and student well-being to be enhanced through respect for professional knowledge and practice<sup>66</sup>

## Policy/strategy framework

Denmark introduced a transformative eGovernment strategy that also recognised the use of ICT in public schools as having an important role in strengthening academic standards. The strategy was designed to drive the adoption of digital solutions in schools and included as priorities:

- Installation of sufficient ICT infrastructure
- Creating a market for digital learning resources
- Creating core competencies and knowledge sharing
- Driving research on ICT-based learning.

The strategy included:

- Ensuring ICT in the curriculum of primary and secondary education, with guidelines on how to embed ICT and media in academic subjects, and
- A focus on learning delivery using digital devices for accessing academic materials and for collaboration.

Digital competency building initiatives included:

- Ensuring the digital competency of teachers through focussed learning, and ensuring those competencies are imparted to students
- Knowledge centres for vocational education training which are used to rapidly develop competencies demanded by the market
- Informatics as a curriculum subject
- Coding classes for students
- Digital assessments of learning progress by students to provide more rapid feedback and targeted learning interventions.

Student management initiatives included:

- Uni-Login – a single sign-on that connects pupils, teachers, parents the school and digital learning resources
- Digital learning platform adoption.

Initiatives around building digital learning capabilities include:

- Fablab@school – an initiative to drive focus on design thinking and digital fabrication
- Future Classroom Lab – to understand emerging technology in a teaching context
- Creation of the Centre for Applied Game Research – to research the efficacy of game-based learning for K-12 amongst other research projects.

Denmark is now considered the world's best in e-government initiatives, and it is now legally mandatory for the government to provide digital public administration, communication and e-services.<sup>83</sup>

## Key insights:

- The convergence of centrally driven policy and focussed innovation and research has been an effective means of driving digital adoption across Denmark's education system
- Denmark is now considered a world leader in digital government, having gone as far as legislating digital service provision by government.

# Ireland

## Background

Ireland's Department of Education and Skills have adopted their Digital Strategy for Schools 2015-2020 to improve teaching and learning outcomes. The vision is to implement digital technologies to enhance student's learning experiences and allow them to become "engaged thinkers, active learners, knowledge constructors and global citizens able to participate fully in society and the economy."<sup>67</sup>

The strategy is focused on four key areas:

- Using ICT for teaching, learning and assessment
- Professional development of teachers
- ICT infrastructure
- Leadership, research and policy.

## Objective

The objective of the strategy is to ensure the education system is effective in responding to digital disruption and its impact on young people and their future careers. Ireland has a goal of having the best educational system in Europe. The strategy hopes to embed digital into the school educational system through the innovative and targeted use of technology.

## Policy/strategy framework

The strategy includes the development of a Digital Learning Framework to examine local and international research on how schools should embed digital into their teaching, learning, management and leadership. The framework also provides schools the means to evaluate their progress in embedding digital technologies and to understand the efficacy of digital technologies in learning and teaching. Students are also encouraged to use digital technologies to learn and present.

An annual action plan contains initiatives across each of the four key areas. Recent initiatives include:

- Using ICT for teaching, learning and assessment – students use digital technologies for presentation and assessments. Their experience demonstrated higher motivation to improve their learning as a result of continuous feedback from teachers and by showcasing work to teachers and peers
- Professional development of teachers – new teachers must have the skills, confidence and knowledge to use technology in their teaching
- ICT infrastructure – in order to support their digital strategy, a stable high-speed internet connection was required. The aim is to deliver 98% of schools with a baseline download speed of 100Mb/s
- A range of technology-enabled initiatives utilising digital technologies such as drones, robotics, educational videos, and online learning platforms as alternative learning delivery approaches
- The inclusion of Internet safety, education on the prevention of cyber bullying and harassment, and extending that education to teachers and parents as well as students.

## Key insights:

- The Ireland example provides insights into the importance of addressing fundamental capabilities in the execution of the strategy
- Cyber security education is equally important to teachers and parents in keeping students safe in the online world
- Ensuring teachers have the appropriate skills and capabilities to support the strategy is critical.



# Australian Capital Territory (ACT)

## Background

The ACT Education Directorate identified diversity as one of the most important factors to consider when designing the education system of the future. The need to personalise education and to celebrate differences among students coming from different backgrounds led the Directorate to develop a plan with the objective of ensuring every child is set up for success. The Directorate had a goal to ensure teachers and schools were empowered and equipped to drive digital pedagogy and to effectively support children.<sup>69</sup>

## Objective

The ACT Education Directorate's strategy sought to leverage existing strengths and address improvement areas by charting four principles or foundations for implementation over a 10-year period.

## Policy/strategy framework

The foundations of the strategy are:

- Placing students at the centre of learning – driving student engagement; having a holistic view of the students; providing an equitable foundation for learning and providing educational pathways personalised for each student
- Empowering teachers, school leaders and other professionals to meet the learning needs of all students – investing in teacher education for creating a high-quality professional workforce and providing professional learning options; empowering school leaders to create conducive teaching and learning environments; and enabling teachers to support students
- Build strong communities for learning – enhancing the participation of student families and the broader ecosystem.
- Strengthen systems that support learning – enabling and providing systems that support learning include: legislation, teaching resources and tools, organisational structure and culture, public accountability and reporting, data and information technology.

The strategy also highlights four supporting principles as well:

- Equity – student achievement sets aside economic, social and cultural barriers
- Student agency – students make decisions about their learning and how their learning environments operate
- Access – supports for learning and wellbeing are available and provided to all students
- Inclusion – diversity is embraced, all students are accommodated and a universal sense of belonging fostered

The strategy implementation includes:

- The development of digital formative assessment tools
- Performance measures leveraging identified data sets
- Design and trials of personalised learning programs and enablement of education access across different settings
- Implementation of digital platforms for personalised education delivery and management
- Adaptive learning tools with the scope to intervene based on identifying patterns in learning

One of the outcomes of the strategy has been the implementation of a 'digital backpack'. This involved the distribution of 4,500 Chromebooks to classrooms, the implementation of a BYOD policy, and the provision of 32,000 students with Google Apps for Education accounts. The Google Apps accounts allow students to work anytime or anywhere and has empowered students to take a more active role in their learning, as well as providing teachers with greater visibility of student learning progress.

## Key insights:

- Although a smaller jurisdiction, the ACT has moved to a one-to-one device ratio target including by implementing a BYOD policy and platform independent cloud-based education services
- The continued rollout of the strategy will see the greater implementation of personalised and adaptive learning approaches.

# Innovations to Leverage



# Sharing Economy

## Description

The sharing economy involves making underutilised assets available in a marketplace to meet demand. It typically involves the use of those assets for short durations or for specific tasks. The sharing economy has been enabled by sharing platforms, technologies that match demand with supply, take care of payments, and track availability. It allows businesses and people to maximise the utilisation of their assets and for consumers to hire or rent goods and services without having to purchase them or enter into longer-term arrangements. The technology is now being used to make available products such as clothing, toys, tools, buildings, manufacturing equipment, cars, houses, caravans, trailers and a host of other items for short-term rent.

The shared economy includes ride-sharing platforms such as Uber and accommodation sharing platforms such as Airbnb. A key point that differentiates transactions occurring on a sharing economy platform from the traditional exchanges of goods and services is that there is no permanent ownership or possession of goods and services exchanged within the sharing economy concept. Driven by the growth of internet, big data and analytics and smart device accessibility, the global shared economy is expected to grow from USD\$14 billion in 2014 to USD\$335 billion by 2025<sup>74</sup>.

## Key implications

- The Department has a vast number of buildings, halls, learning spaces, playing fields and other assets that could potentially be utilised more effectively, improving community outcomes and generating additional revenue

### FLOOW2 business-to-business (b2b) sharing platform<sup>75</sup>



FLOOW2 is a b2b sharing marketplace on which companies can share equipment, personnel, services, facilities, waste management and materials. The platform brings organisations together to share overcapacity, leading to new revenue and cost saving opportunities, along with the development of a sustainable network of potential ecosystem partners.

FLOOW2's b2b sharing marketplace enables companies to share their surplus capacity in terms of underutilised assets in a safe and transparent manner. FLOOW2 also lets users within the same organisation create sub-sharing platforms, to share certain items only within a certain organisational units or regions <sup>76</sup>.

Broad products/services shared on the platform include:

- Industrial equipment and products
- Waste management and materials
- Services and facilities

### TRRINGO farm equipment sharing platform <sup>77</sup>



TRRINGO is a farm equipment sharing platform in India that lets farmers exchange tractors and other agricultural equipment with each other. TRRINGO is a pay-per-use farm mechanisation platform that lets farmer leverage mechanised farm inputs, get access to tractors, implements or self-propelled equipment at lower cost. The platform has safeguards to ensure equipment meets quality standards. TRRINGO can also be used provide professional drivers for farm equipment.

# Gig Economy

## Description

The gig economy is the emerging labour market of task-based, or 'gig' work, where workers charge their fees on a per task basis and are not subject to employment law. Smart devices and platform technologies have enabled the rapid expansion of such temporary work arrangements. Much like the sharing economy, workers can offer their capacity for short task-specific jobs. Instead of a salary, these workers get paid for the "gigs" they complete such as completing the delivery of food, driving a passenger from A to B, or mowing a lawn.

The gig economy can provide flexibility to the workers as well as enterprises. Workers may enjoy the benefits of working their own hours, while businesses can engage people on an as-needed basis without incurring staffing overheads. Organisations can leverage the gig economy to access people with niche skills for short-term roles. Digital intermediation has enabled employers to connect directly with communities of workers. Digital platforms have created large-scale and efficient marketplaces that facilitate direct and real-time connections between customers who need a service performed and workers willing to provide that service.

## Key implications

- The gig economy is providing flexibility and scalability in meeting short-term workforce demand
- Platforms of this nature could potentially simplify the process of engaging casual and replacement teaching staff, more readily matching demand with supply

### Upwork platform for hiring experts for organisations <sup>78</sup>



Upwork is an online platform to enable businesses to get one-off tasks get done by connecting to a network of freelancers to work on projects ranging from web and mobile app development to social media marketing and content writing. Businesses, based on their requirements, are matched with the right freelancers on the platform. Businesses can browse profiles, review proposals and interview top candidates. The platform enables businesses to chat, share files and collaborate on the go.

The platform has a time-sheet application that tracks time and takes screenshots while the freelancer is working <sup>79</sup>. Invoicing and payments happen through Upwork with the security and assurance that the platform offers. Some popular categories for hiring on Upwork include:

- Web Developers
- Mobile Developers
- Designers and Creatives
- Writers
- Customer Service Agents
- Sales and Marketing Experts
- Accountants and Consultants

### Airtasker enables users to outsource daily tasks <sup>80</sup>



Airtasker is an Australian start-up that lets users outsource their daily tasks to skilled workers. The platform enables users to choose a skilled worker for their task based on a rating and review system. Workers have an option to bid for a task. All payments between users requesting a task and workers performing a task are managed by Airtasker. The platform also supports small businesses and enterprises. On the listing of a job, the platform allows users to select local workers, have them bid for the job, enables communication through the platform's private messaging system and facilitates payment. The platform leverages analytics to provide personalised marketing and communications to its users.

# Crowd-sourcing Analytics

## Description

Crowd sourcing and open innovation concepts allow organisations to optimise research for solutions to complex problems by calling on vast amounts of typically voluntary crowd effort. Data science talent shortage, complexity associated with implementing sophisticated analytics solutions, quick results and the need for outside validation are some of the main reasons why organisations use crowdsourcing for data analysis. Crowds can be engaged through the establishment of communities of altruistic like-minded individuals, or by data science competitions. Such competitions for crowd sourcing solutions have growing communities of users who are being leveraged for ideation and discovery phases of solution development, for model and algorithm refinement and for recruiting top analytics talent.

Top benefits of crowdsourcing analytics are:

- Bring in the human element to insight generation – from sentiment analysis to content moderation, for certain use cases, bringing in the human touch adds more value than automation
- Time savings – the distributed nature of crowdsourcing can mean data analysis happens at a very fast pace, with many people potentially working in parallel
- Internal resource savings – crowdsourcing can allow organisations to use their internal data science and analytics talent sparingly for the most high priority tasks, ensuring maximum cost-effectiveness
- Fast scaling – with crowdsourcing, an organisation has access to a large pool of analysts on demand.

### Spare5 is an on-demand work platform for crowdsourcing insights <sup>81</sup>

spare5

Spare5's business involves a two-sided marketplace that connects groups of data analysts and data scientists, with skills to help filter, clean data and help generate insights. On the other side, the platform attracts businesses seeking to get insights on their data sets. The concept was to enable people to earn extra money at their personal convenience, drawing on their individual skills and experience. The platform analyses the skills of these people and assigns micro tasks among a group working on the data. The platform's algorithms rate each individual worker on specific tasks. Companies predominantly use the Spare5 platform for three areas – training AI models, search optimisation and cleansing data. Spare5 breaks down assignments into micro tasks and attempts to match the tasks with the best suited available individuals.

### Kaggle online data modelling platform <sup>82</sup>

kaggle

Kaggle is an online platform for data-mining and predictive-modelling. The platform combines crowd-sourcing and data-transformation. A company wishing to create an algorithm or analytics model may use Kaggle. Kaggle prepares the data and a description of the problem, frames it into a competition and anonymises the data. For most competitions, submissions are scored rapidly and summarised on a live leader board. Kaggle helps companies integrate the winning model into their operations as well. Providing cheap access to a large pool of data scientists enables organisations to utilise the power of data analytics at minimal cost. After the winner is announced, the statistical and analytics models and tools used to build the model are disclosed.

## Key implications

- Crowd-sourced analytics are presenting as a viable method of undertaking large-scale complex data analysis
- Hypotheses can be tested at low cost, potentially enabling the derivation of valuable insights

# Biometrics

## Description

Biometric technologies measure person-specific physiological characteristics to facilitate identification. Biometric authentication is typically used validating identity and permitting access to physical or digital environments. It may also be used for personalising service provision with conversational user interfaces.

Biometric identification systems are divided in two broad categories – physiological identification which uses facial, fingerprint, hand geometry and iris data and behavioural identification which uses patterns in speech or signature for identification. Modern biometric devices are portable and along with the usage of smartphone based biometric sensors, are driving growth of the biometric technology trend.

From healthcare to border control, mobile biometric devices are finding applicability across a host of use cases. In response to more sophisticated fraud attacks, biometric technology is expanding into the retail and consumer marketplace as a quick and efficient payment authentication mechanism. Some organisations are utilising biometric devices for easing the process of tracking employee time and attendance, and for facilitating access to physical sites. Besides the popular identification and validation uses cases, biometric technology is also being leveraged to collect user data for better service and product design. Enforcing data protection and privacy protocols becomes extremely important since biometric technologies can deal with sensitive personally identifiable information.

## Key implications

- Biometric authentication can improve the security of smart devices, laptops and tablets, while eliminating the need for students to remember or type passwords. This can improve the accessibility of these devices as well as their utility in earlier years of education
- Some schools are using biometric identity systems to automate administration processes such as student registration, attendance, exam monitoring, and lunch payments.

### Australian Border Force using SmartGate <sup>87</sup>



The Australian Border Force (ABF) uses the SmartGate system at all ten major Australian international airports. The system requires a biometric-enabled ePassport to be scanned, and the traveller is identified using facial recognition technology. SmartGate is in operation at ten Australian international airports. It has reduced passenger processing wait times and is less error prone in identifying travellers. The ABF has a goal of 90% of international travellers being processed by SmartGate by 2020.

### NAB using voice assistants to provide a better banking experience <sup>88</sup>



NAB has created applications for Google Assistant and Amazon Alexa to provide “hands-free banking”. The application uses voice recognition to identify the customer. Once their identity is verified, the customer can ask the voice assistant about their account balances and can transfer funds between accounts. NAB responded to changing customer expectations about more innovative digital experiences in banking. The application provides a simple and secure way of using biometrics for customers to authenticate and manage their money.

# Appendices



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