

Changing minds in a changing world

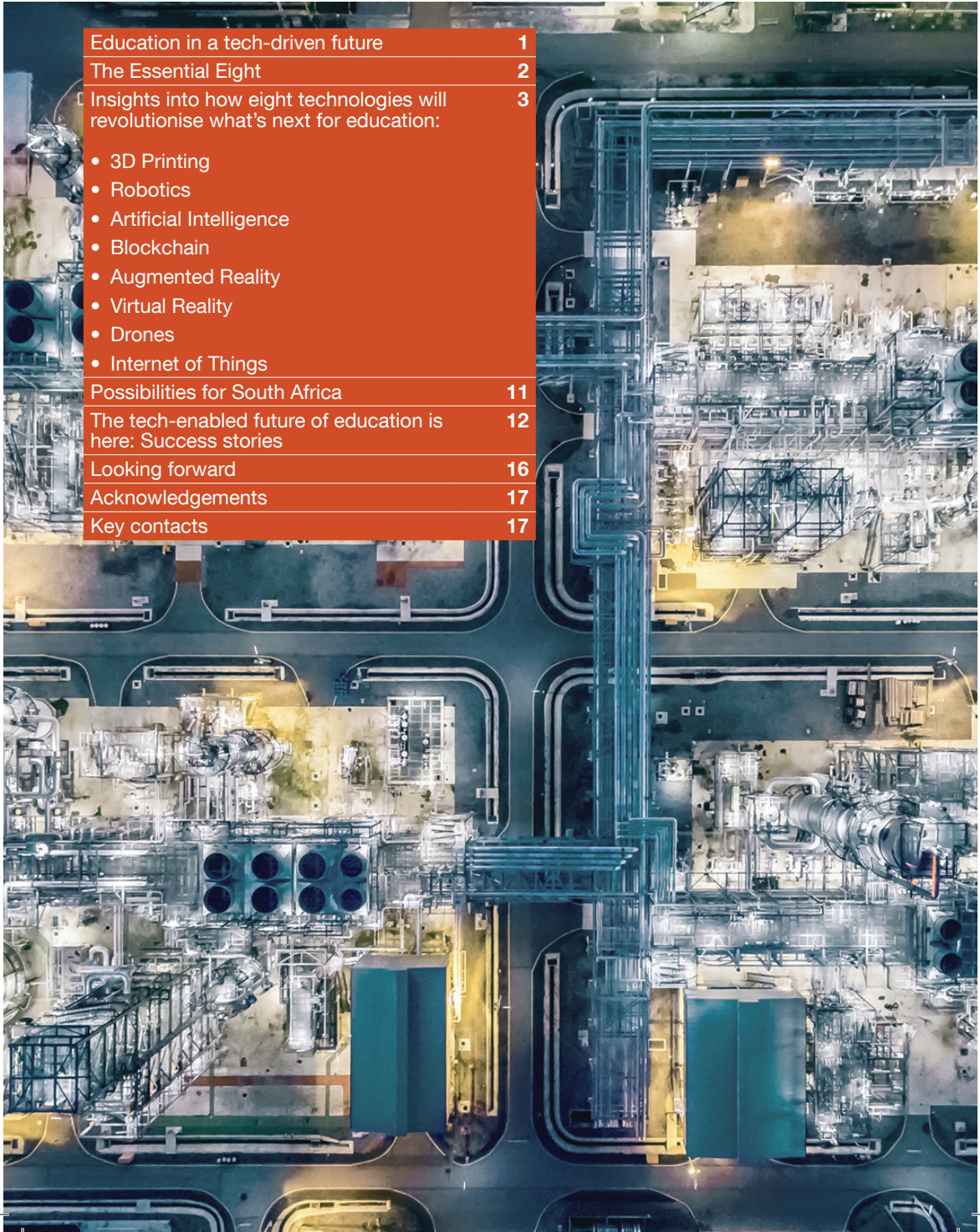
```
elif _operation == "MIRROR_Z":  
    mirror_mod.use_x = False  
    mirror_mod.use_y = False  
    mirror_mod.use_z = True  
  
    #selection at the end -add back the deselected mirror  
    mirror_ob.select= 1  
    modifier_ob.select=1  
    bpy.context.scene.objects.active = modifier_ob  
    print("Selected" + str(modifier_ob)) # modifier ob is  
    #mirror_ob.select = 0  
    #name = bpy.context.selected_objects[0]  
    #my_data.objects[my.name].select = 1
```



The future of education in the
Fourth Industrial Revolution

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Education in a tech-driven future

In this increasingly digital-enabled world we live in today, it's clear that emerging technology needs to be embedded in every organisation's DNA. Technological advancements often have a negative connotation attached to them. These changes are causing anxiety and insecurity in many employees who feel that automation is a threat to their jobs. According to the World Economic Forum's Future of Jobs analysis, 39% of core skills in South Africa required across all occupations will be different by 2020. Machines are replacing people's jobs and it is not just affecting the poor and uneducated, it is a sentiment shared by many employees across industries. In a recent PwC publication titled "Workforce of the future – The competing forces shaping 2030" it was pointed out that these technologies could create a world where human abilities are amplified as machines help humankind process, analyse and evaluate the abundance of data that creates today's world, allowing humans to spend more time engaged in high-level thinking: creativity and decision-making.

Education has always been viewed as the process of acquiring knowledge through formal training, but education today means being prepared to deal with the unexpected and adapting to new ways of doing things, while still trying to make a difference by working on complex projects with other universities and partner organisations.

The rapid development in technology, such as smart mobile phones, wearable devices and sensors, cloud-based IT, advanced analytics and the Internet of Things, is changing business and operating models across all sectors, including education. These technologies present new opportunities to improve or redefine the educational experience through activities, including teaching, learning and research.

Executives now face the challenge of working through the noise to make clear decisions about the most impactful technologies that will sustain revenue growth and enhance student experience. With the overwhelming breakthroughs in emerging technology we are exposed to each day, how do executives even know where to begin?

To help organisations focus their efforts, PwC analysed more than 150 emerging technologies to pinpoint the 'Essential Eight'. These eight technologies, we believe, will have the most significant global impact across sectors.

To arrive at the Essential Eight, we evaluated the various technologies' business impact and commercial viability over the next five to seven years (or as little as three to five years in the case of developed economies). Specific criteria include: the technology's relevance to companies and industries; global reach; technical viability, including the potential to become mainstream; market size and growth potential; and the pace of public and private investment in them.

The Essential Eight are the technological building blocks that every organisation must consider. Their real value is unlocked when they converge. While each institution's strategy will vary, it is these Essential Eight technologies that will transform educational institutions.



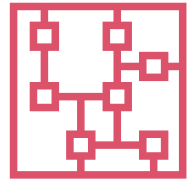
The Essential Eight are emerging technologies that PwC believes will significantly impact the world and education sector in the near future



Artificial intelligence



Augmented reality



Blockchain



Drones

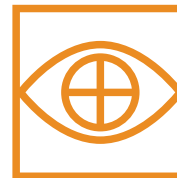
The Essential Eight



Internet of Things



Robotics



Virtual reality



3-D printing

Insights into how eight technologies will revolutionise what's next for education

3 D Printing

3D printing is the process of creating a three-dimensional object by successively printing layers of materials on one another until an object is formed.



Impact on the world

3D printing, also known as additive manufacturing, is democratising manufacturing and is a transformative technology. It is entering every sector of our economy.

Impact on education

3D printing systems such as STEM kits added a new dimension to the classroom by integrating 'making' into learning. Curricula in educational institutions are in support of learning methods and techniques that make learning about science, technology, engineering and math concepts enjoyable for learners.

Where this has been successfully used

- Hanze University uses 3D printing in its natural and medical science programmes. 3D printing offers the ability to create human tissues to gain a greater understanding of the human body. 3D printing is allowing students to apply what they have learnt in the classroom to real-life situations.

A prime example of this is the creation of different prototypes of an artificial heart by two students. This enabled them to use a virtual reality simulation so that they could practise chest compressions.

- Scripps Institution of Oceanography uses 3D printing in its Institute for Geophysics and Planetary Physics departments to produce components for the institution's ocean-bottom seismology instruments. Benefits of this have been decreased costs and greater efficiency within the department.
- University of Michigan used 3D printing to produce an airway splint which was used to treat a very rare disorder found in babies known as tracheobronchomalacia. This disorder causes the windpipe to periodically collapse and prevents normal breathing. The bioresorbable splints, which are designed to grow with babies and eventually dissolve, have helped keep four children's airways open.

Robotics

Robotics is the combination of engineering and computer science to create, design, and operate mechanical devices, i.e. robots.



Impact on the world

Robotics is transforming manufacturing and non-manufacturing operations with new capabilities that address the challenges of working in changing, uncertain, and uncontrolled environments, such as alongside humans without being a danger to them.

Impact on education

Robotics and simulators can change the way students learn and ultimately create a more knowledgeable and well-adjusted student. In medical practice robots can be employed as stand-ins for human subjects. They can be created and programmed to give all indications of human life, including breathing and heartbeat.

Where this has been successfully used

- University of Pretoria employed Libby as its new robot librarian who is able to perform mundane everyday tasks performed by library staff, allowing the staff to perform more advanced specialised tasks.
- Georgia State University (GSU) uses an AI chatbot to respond to questions about enrolment and financial aid.
- Deakin University in Australia has created a platform, Genie, that combines chatbots, AI, voice recognition, and a predictive analytics engine to create an intelligent virtual assistant that provides students with advice. Chatbots are being tested as English tutors as well.
- The Academy for Software Engineering (AFSE) in New York City uses Code-E, a life-size robot, to bring technology to life: students can interact with the robot and ask him questions, making learning about technology more interesting and interactive.

Artificial intelligence

AI is an umbrella term for 'smart' technologies that are aware of and can learn from their environments to assist or augment human decision-making.

Impact on the world

AI technologies offer the promise of boosting productivity and creating new products and services. Machine learning carries enormous potential for the creation of meaningful products and services. For example, hospitals can use a library of scanned images to quickly and accurately detect and diagnose cancer. Insurance companies can digitally and automatically recognise and assess car damage. Or security companies can trade clunky, typed passwords for voice recognition.

Impact on education

By using AI to perform time-intensive tasks, administrative staff can re-focus their efforts on improving student experiences at their institutions. Application and admin processes can also be made more efficient through AI, as can tasks like the capturing of tests/assignments.

Where this has been successfully used

- Philipps University unveiled a humanoid teaching assistant – Yuki – in Germany. The robot is Professor Jürgen Handke's assistant, who helps with teaching and learning. Yuki can get a sense of how students are doing academically, what kind of support they need and also have them take tests.
- Staffordshire University (UK) uses Beacon, an AI education tool, to assist students and answer their questions, in addition to handling general queries. The chatbot can be downloaded via a mobile app, and students can chat with Beacon through text or voice conversation. As its use increases, the bot becomes smarter. Beacon is said to enhance the student experience by answering timetable questions and suggesting societies to join. It can also apply for an exemption from council tax, order new student cards and connect users to lecturers. The report notes that, eventually, the chatbot will be able to remind students about classes and deadlines.
- Bolton College uses chatbot Ada, which is available 24/7 to answer students' questions, measure attendance, grade profile and measure whether students are performing on par. Students who tell Ada they're feeling depressed or allude to self-harm are informed that the information will be shared with the college's mental health team.

Blockchain

Blockchain technology is a distributed shared ledger where transactions are recorded and confirmed without the need for a central authority.



Impact on the world

Blockchain has the potential to usher in an era of autonomous digital commerce.

Impact on education

Blockchain will revolutionise academic credentialing. It will enable students to hold and share their own official records directly with others in a manner that is safe, tamper-proof, and trusted. Blockchain has also opened opportunities for students to pay their tuition fees using blockchain currency such as bitcoin, which is a more secure method.

Where this has been successfully used

- MIT developed an open standard for verifiable digital records. The Institute issued learner-owned academic credentials on Blockchain.
- Southern New Hampshire University has issued Bachelor's and Associate's Degrees to its Spring 2018 College for America graduates as both paper diplomas and as Blockcerts. A Blockcert is a digital document anchored to the blockchain for instant verifiability anywhere in the world. Students have to wait up to 10 business days for paper diplomas, but Blockcerts can be issued immediately upon graduation, meaning students leave with a record of achievement they can use right away to apply for jobs, promotions, or graduate school.
- Central New Mexico Community College uses Blockchain to issue digital diplomas that are securely and easily accessed on a student's smartphone. These diplomas, which have been issued to students in the CNM Ingenuity programmes during a pilot phase, can never be tampered with, will never disappear, and can easily be sent from a student's smartphone and be verified by a potential employer.

Augmented reality

Augmented reality (AR) is a data or information 'overlay' on the physical world that uses contextualised digital information to augment the user's real-world view.

Impact on the world

Marketing and advertisement fields will explode with augmented reality devices. Augmented reality is the future that will allow consumers to experience a reality that is based on personal needs and desires. AR will present a completely new way to engage and will expand the abilities of retailers as well.

Impact on education

AR provides the opportunity for visual and immersive learning opportunities. AR allows different types of simulations which students can learn from – e.g. in aviation studies, where flying an aircraft can be simulated, or in medicine, where doctors can simulate an operation.

Where this has been successfully used

- Eastern Michigan University: to help students grasp concepts in Earth science, a professor built an AR sandbox using a Microsoft Xbox Kinect camera, digital data projector, computer, and simulation and visualisation software. Students could create mountains, volcanoes, river channels, glacial deposits or virtual rain by manipulating a digital map projected on a box of sand.
- University of Canberra, the Australian National University and Macquarie University: The Special Collections using Augmented Reality to Enhance Learning and Teaching (SCARLET) project digitised rare books and manuscripts held in the John Ryland's library in Manchester. An app was created which enables students to see and handle original materials while providing an additional layer of imagery, resources and information to augment the learning experience.
- Stanford University and Ohio State University use Google Glass, an optical head-mounted device or 'pair of glasses', in medical education, which enables doctors to see an operation from a resident doctor's perspective and provide real-time guidance on a procedure.

Virtual reality

Virtual Reality (VR) is a simulation of a 3D image or complete environment where a user can interact in a seemingly realistic way.



Impact on the world

Bring the world closer together. VR will help connect the world and give people visual and immersive opportunities.

Impact on education

Institutions are using VR to augment programmes in criminal science, healthcare, agriculture and fine arts. Through VR, students can practise and train in their field of study. Students studying history could explore landmarks and historical sites; anatomy students could identify and practise procedures on virtual human bodies; and students studying education could practise teaching with the use of virtual students to become more comfortable in the classroom.

Where this has been successfully used

- Western University of Health Sciences lets students learn about anatomical functions by moving layers of virtual tissue to view more than 300 anatomical visualisations, created using scans of real patients and cadavers.
- Harvard University – Virtual Immersion: French Culture and Language through 3D Video. In Nicole Mills's French language and culture classes, students meet native speakers at parties in their homes and eavesdrop on conversations in Parisian cafés, all without leaving the classroom. Cultural immersion is a tried-and-tested element of language instruction, and this project brings students into the 11th arrondissement of Paris through VR film narratives.
- University of Westminster built a virtual space for criminal law students, in which they hunt for clues to construct a murder case. Rather than simply reading witness statements, they can walk around a building and judge whether someone would have been able to see the crime.

Drones

Drones are devices that fly or move without the presence of a pilot and can be used to collect a wide range of data or execute tasks remotely.

Impact on the world

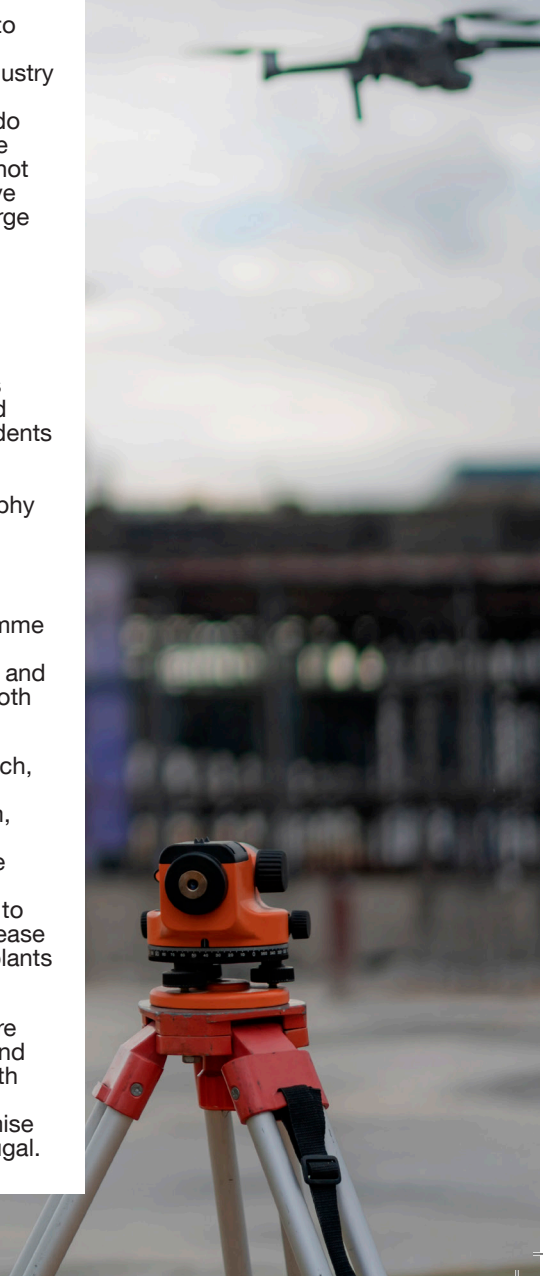
Industries have been using drones in many of their operations – from oil companies that want to monitor their pipelines to real estate agents who want to take aerial shots of a property. Retail industry companies (e.g. Amazon) will start using drones to deliver parcels as opposed to having people do this. Agricultural and wildlife conservation can be monitored by drones in places that humans cannot reach and be able to detect things the human eye may not necessarily be able to see due to the large scale of these areas.

Impact on education

Students can envision themselves in class using drones to learn high-tech jobs and handle real-life challenges with drone technology. Educators would be able to teach a wide range of skills and supplement more traditional lessons to help students retain information in a new way. For instance, lecturers might enhance international students' English language skills by using drone photography to inspire writing exercises.

Where this has been successfully used

- A Kansas State Polytechnic University programme takes a hands-on approach to training, 'giving students the necessary skills to safely operate and manage a diverse fleet of unmanned aircraft both proprietary and commercially available'.
- Idaho State University researchers use high-tech, drone-mounted cameras to detect diseased and stressed potato plants. The research team, led by Donna Delparte, assistant professor of geosciences at ISU, is also planning to use the spectral signature of plants – detected during greenhouse testing using advanced sensors – to develop algorithms that can automate this disease detection, allowing the quick removal of sick plants from the field.
- Southampton University uses drones to capture the imagery of riverbanks to monitor erosion and flooding of coastal regions. In collaboration with colleagues at the University's Institute for Life Sciences, drones are being used to help optimise water conservation in crop production in Portugal.



Internet of Things

The Internet of Things (IoT) extends network connectivity and enables a diverse range of devices to collect, process, and send back data.

Impact on the world

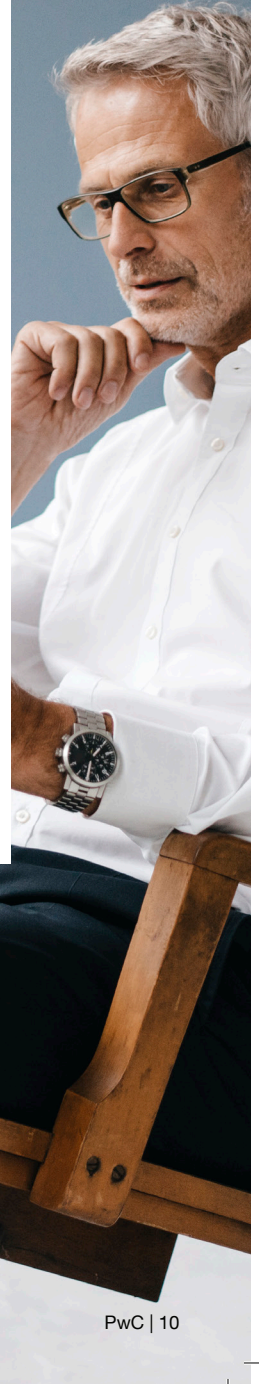
Interconnectedness of society: users of the internet can collect, receive, and communicate with each other via Internet Protocol address. By increasing efficiency and simplifying processes, IoT can be of great help to businesses. IoT allows insurers to move more quickly and make powerful data-driven decisions. Companies no longer have to wade through paperwork, and can instead move through the claims process more efficiently.

Impact on education

Immersive and connected educational spaces; connected infrastructure; safer, more efficient use of space; personalised learning; increased sustainability and cost savings with AI-powered research.

Where this has been successfully used

- University of Washington uses IoT to collect data on power and building controls to monitor HVAC and lighting systems in order to ensure peak efficiencies. Traffic in rooms and buildings also can be monitored to adjust HVAC settings to their optimal level, conserving energy and reducing costs.
- University of New South Wales uses IoT sensors to monitor energy consumption.
- Virginia Tech uses alert systems that notify students, faculty and staff of emergency notifications via smartphone and smartwatch. Campus lighting can be controlled through IoT devices to ensure that less-secure areas are well lit at night. Intelligent video surveillance systems are used to identify potentially threatening situations and notify the proper security personnel immediately.



Possibilities for the Essential Eight in South Africa

Skills training

3D printing can be used to print things such as organs for medical students or car parts for mechanical engineering students. This gives students real-life experience in a less risky environment and helps students gain practical experience in their fields and acquire their required skill sets well in advance of starting their careers. Virtual reality and augmented reality simulations provide another way to help students garner the necessary practical experience they require for the world of work. Students can be immersed in a practical environment in their field of study. One of the biggest benefits to training people in this way is that students can learn from realistic scenarios without the risk of practising an unfamiliar skill in an uncontrolled real-life situation.

Task-based learning

IoT could have a profound impact on the way teaching occurs. Connected systems can free up teachers from recording and monitoring students, which then enables them to facilitate learning rather than merely regurgitate information from the students. In task-based instruction, students learn by doing and teachers assist when needed. IoT systems provide feedback, assistance, and classroom-level monitoring automatically. By signalling to teachers for help and by increasing difficulty when necessary, no student falls too far behind or gets too far ahead.

Teaching and instruction

There will always be a role for teachers in education, but what that role is and what it entails may change due to new technology in the form of intelligent computing systems. AI can take over tasks like grading, can help students improve learning, and may even be a substitute for real-world tutoring. AI systems could be programmed to provide expertise, serving as a place for students to ask questions and find information, or could even potentially take the place of teachers for very basic course materials. In most cases, however, AI will shift the role of the teacher to that of facilitator. Teachers will supplement AI lessons, assist students who are struggling, and provide human interaction and hands-on experiences for students. In many ways, technology is already driving some of these changes in the classroom, especially in schools that are online or embrace the flipped classroom model.



The tech-enabled future of education is here

Success stories

PwC New York City preparing students for the tech future

Half a million jobs in computing are currently open, with an estimated one million more computing jobs than applicants who can fill them within the next year. PwC wants to close that gap. To do it, we need to prepare a future workforce with digital and tech skills, which means we need young people to fall in love with technology.

When we teach technology, we need to think about creating a more personal connection by sharing stories, sparking imaginations and making learning both fun and real. We thought a way to bring technology to life was to bring a walking, talking robot to the students. The students can interact with it, and we can show them how it works and then answer their questions.

PwC has rolled out CODE-E, a life-size robot designed to interact with kids with the goal to spark their interest in technology.

‘The first time we brought CODE-E to a school, the students sat in their seats and listened to CODE-E talk, and then they brainstormed ways technology could change something in their lives. The students had a hard time coming up with ideas and quickly lost interest. So, our teams put their heads together and revised the lessons to heighten their empathy skills by enabling students to have a conversation with CODE-E, and to increase engagement in the lesson by prompting them to think about how they could solve a problem they face personally in their school using technology.

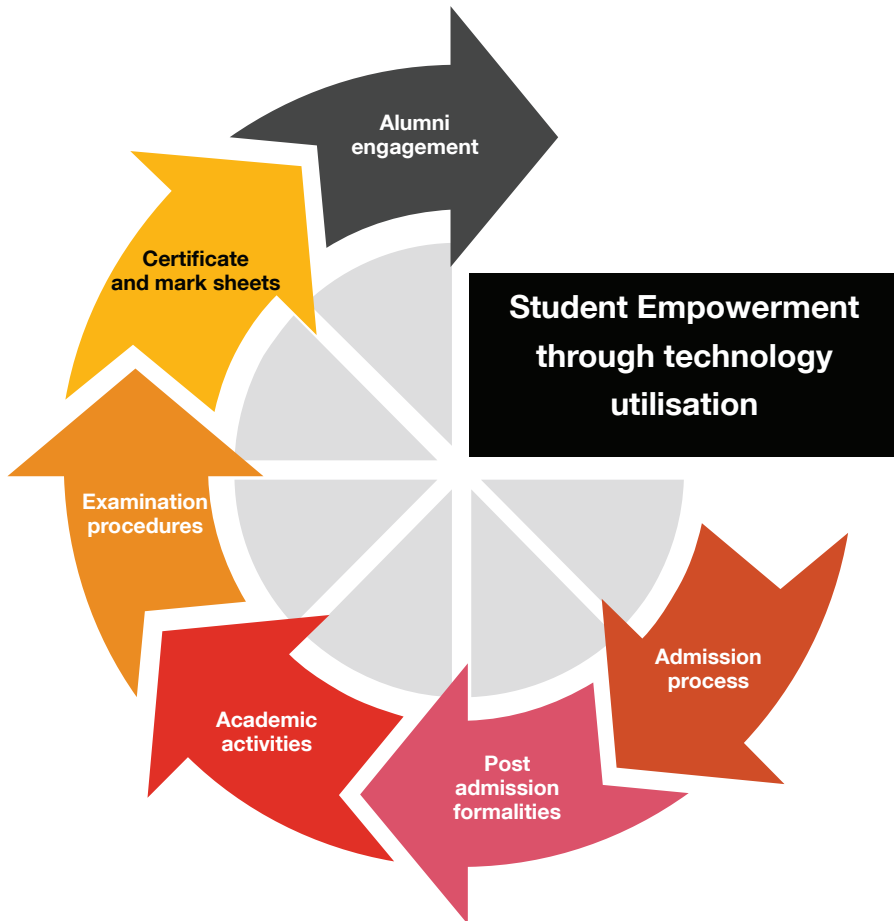
‘By our third school visit, to the Academy for Software Engineering (AFSE) in New York City, we urged students to focus on something practical they would like to change. The students got excited and immediately started churning out ideas: an app to let students know when a seat was available in the overcrowded cafeteria at lunchtime, an automated system to provide access to the restrooms, and a digital system to check them in every morning so they could spend less time waiting in line, and more time learning in the classroom.’

To help teachers develop the skills they need to be able to teach their students about complex digital concepts, PwC developed a customised version of PwC’s Digital Fitness App, a mobile platform that helps explain digital subjects to teachers. We worked with six teachers and eight graduate students to review the app and help us develop content. Teachers are given free access to the app. After they download the app from the app store, teachers complete a digital assessment that evaluates their current digital acumen. Then teachers receive a list of recommended resources to educate them about digital topics, such as coding, data analytics and machine learning.

Success stories

Student Information System operations in India

PwC India has been digitising the student journey across 200+ government colleges based in rural areas of India through their Student Life Cycle Management (SLCM) Solution.



SLCM is a one-stop solution to manage the entire life cycle of students from registering for admission through graduation and as an alumnus. Key functions of SLCM include Admission Management, Course Management, Academics Management, Fees Management and Examination Management.

This system has been developed by PwC using Microsoft Dynamics and has transformed the functioning of 200+ colleges and is providing an efficient digital interface to more than 200,000 students based in rural India. The potential for data analytics to improve the quality of education services is also being explored.

Success stories

Robotics Process Automation (RPA) at the University of Auckland, New Zealand

To support its functional (operating model) review and business process improvement initiatives, the University of Auckland has simplified and standardised its back office processes, as well as reduce the costs of administrative functions. This will allow it to fund initiatives that will attract new students, and better support them throughout their time at university.

Many back office processes in Finance, Academic Services, HR and IT are manual and inefficient, requiring a large number of staff to do repetitive and low-value activities. The university sought to understand whether it could set up a self-sufficient Robotic Process Automation (RPA) capability that would quickly realise efficiency savings, improve the quality and controls around business-critical processes and support its transition to the future-state operating model.

RPA is the use of software to replicate human tasks within a business process. The RPA software is effectively a highly configurable workflow tool, and the 'robots' that run on the software are provided with access to systems and databases to carry out the tasks. The robots can be triggered to run at specified times, or they can be triggered by a person to run on an ad hoc basis, depending on the business need.

PwC was initially engaged to deliver a pilot of the RPA technology. The team completed process assessments across the back office functions, supported the RPA technology procurement process and successfully 'productionised' an automated process (using UiPath software) that allows students to request, pay for and receive digital versions of their academic transcripts and official letters with minimal human intervention. In parallel, PwC delivered a change management strategy and a design for the RPA 'Centre of Excellence' – the structure and resourcing requirements for the university to manage the RPA capability going forward. The combined PwC and university team has now delivered two live automated processes, with a third currently in development.

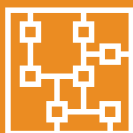
Key outcomes

The first three automated processes will release c. NZ\$700k of annualised operating cost savings, and the team has identified a strong pipeline of additional candidate processes for development during 2018. The project has achieved full ROI in around 14 months.

Success stories

Digitising the student journey in the USA

In an increasingly competitive landscape in which Millennials are giving way to the digital native 'Generation Z', it is critical that universities reimagine the way in which they interact with their students so they can provide them with a truly distinctive, digitally enabled experience at every stage of their journey.



Connected

- 24/7 access to digital classroom content, such as lecture recordings and notes.
- Ability to view and complete coursework via mobile device.
- In-the-moment grading and feedback from professors.
- I have access to my professors and peers 24/7 through digital channels



Interactive

- Availability of digital content, replacing the traditional, costly textbook model.
- Dedicated class time for discussions and other interactive teaching methods.
- 'I want to learn in a way that is most cost-effective and stimulating to me'.



Accessible

- Professor's office hours held over video chat.
- The ability to customise the curriculum based on student preference.
- 'I have access to my professors and peers 24/7 through digital channels.



Career-oriented

- Tailored curriculum based on student needs and career alignment.
- Entrepreneurial coursework available.
- 'I feel prepared for a career upon graduation'.



Engaging

- Engagement with the student body, supporting participation, learning and inclusion.
- 'I can engage with my educational community and have my say and contribute'.

Looking forward

Breakthroughs in emerging technology are changing the way we live and work by providing us with access to innovative solutions in education around the world. The world is moving faster each day, and as human beings we need to be able to keep up and advance with it.

While there are many applications for the use of emerging technology in education and the private sector alike, we need to consider the technological maturity of the country we live in and have a comprehensive view of problems faced by the population in order to effectively use emerging technology to increase the efficiency and effectiveness of services provided to citizens.

Educational institutions should not treat emerging technologies as a hype mechanism and jump aboard due to fear of being left behind. Instead, leaders must carefully consider which technologies will have the most impact in their environment and, ultimately, how these technologies can be used to solve the most pressing issues which will benefit the broader society.

When it comes to sustaining a competitive advantage, emerging technologies have their use in improving the core and support functions of the institution as well in the academic environment. Academics, the public and private sector need to work together to realise the value of emerging technologies. To be effective, institutions should consider a blended approach in embedding these technologies in their institutions while ensuring that value is realised from a strategic perspective.

New technologies will always be in our midst and it is important to recognise that emerging technologies should form part of a wider digital ecosystem within our businesses and should be a component of a strategic digital transformation strategy within the institution, and not just a one-hit wonder. As referred to in a recent PwC publication titled “Preparing for tomorrow’s workforce, today”, some of the actions we identify to minimise the technological change ‘at risk’ gap are also used to create a sense of purpose, development and execution of a great employee experience.

Institutions should take gradual steps to digital transformation by focusing on demonstrating success through a handful of lighthouse projects, which solve real problems for the institution and broader society and prove the value of emerging technologies for the sceptics and naysayers.

Lighthouse projects should be simple to implement and should allow for the quick realisation of value in the form of measurable return. An example of such may be the use of robotics process automation to streamline manual finance processes, which can be measured by showing the amount of time saved through automation that has a direct financial saving.

Similarly, a blockchain lighthouse project can be used to test the effect of using blockchain to verify student degrees. This can be run on its own and be tested for value without affecting the direct operations of the institution. These lighthouse projects, which can be undertaken in collaboration with start-ups or large corporates, could help firms garner stakeholder buy-in and support by demonstrating successful implementation and tangible benefits.

Innovation is crucial for educational institutions to remain competitive in the era of digitalisation. Strengths like university size and prestige, which used to be at the core of higher education competitiveness, can no longer be depended upon solely as new entrants capitalise on technologies to disrupt traditional business models of education.

Therefore, it is important that educational institutions stay at the forefront of innovation and are agile enough to adapt their business models to changing needs.

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