Technology &
Pedagogical Innovation

REPORT TEAM

Dasha Karzunina

Dasha is a Market Insights Manager at QS, combining a public-facing role with extensive involvement in QS Intelligence Unit's research, analysis and rankings delivery. She specialises in qualitative research, having run focus groups with prospective international students from all over the world. Leading on key partner relationships, she regularly liaises with university officials and presents at higher education conferences. Coming from a student leadership background, Dasha previously represented the academic interests of over 30,000 students in one of the biggest Students' Unions in the UK.

Josie West

Josie is a Market Insights Researcher at QS. She works on new content in the form of reports, articles, blog posts, conference proposals and presentations. Josie has extensive experience with social and qualitative research, using a variety of methods including surveys and interviews.

Jack Moran

Jack Moran is Public Relations Executive and Education Editor at QS. He has overseen the judging process for the Reimagine Education Awards, and has contributed to the organization of this year's conference agenda. He will be moderating a panel convened by him, 'Rethinking the Role of the Educator', at this year's event. His analysis of QS's rankings has appeared in The Guardian on numerous occasions.

Georgia Philippou

Georgia Philippou is a Graphic Designer at QS. She creates innovative infographics and visualisations based on QS research and rankings. Her work is featured on TopUniversities.com, TopMBA and across the company's social media channels. Georgia is the lead designer for a range of print and online publications, including a popular range of guides for prospective students, as well as market research reports for higher education professionals.

Technology is evolving at rapid speed to enter our homes, personal lives, work and, of course, the higher education (HE) sector. Institutions must adapt to meet the demands of this changing environment, but cannot always keep up with the speed at which technology is being disseminated.[1] Knowing exactly how and when to implement it is a hurdle in itself. Moreover, as technology's role expands in both the public and private spheres, facilitating education and bonds between people, so too does the role of ethics in its distribution. Considerations such as confidentiality, isolation and even addiction must play a part in any HE provider's concerns when implementing any new technology-dependent pedagogy.[2] Limitations aside, it is also true to say that technology can reduce or remove existing barriers to education, trigger monumental change and pedagogical innovation, and open pathways to HE for previously marginalised groups.[3]

The annual Reimagine Education Awards, which QS presents in collaboration with the Wharton School's SEI Center for Advanced Management, includes six awards concerned with technology and pedagogical innovation. The following section identifies the areas in which technology is having the biggest impact, including: e-learning, blended-learning, augmented and virtual reality, and adaptive learning. It will also identify and examine key trends and challenges.

E-Learning

E-Learning has become increasingly prevalent, and has seen significant advancement over the last decade. Online modes of learning offer enhanced flexibility, providing greater access, contributing to the 'massification' of HE and appealing to 'non-traditional learners.'[4] As emerging economies such as India and China continue to produce extremely high numbers of students, demand for HE is projected by many to grow substantially. By 2025, over 250 million students, worldwide, will want access to HE.[5] Technology has made meeting this demand conceivable.

Traditional courses are still likely to involve some form of e-learning, with the introduction of online systems, e-journals and virtual libraries. This demonstrates the pervasiveness of technology, and our reliance on it across both new and old platforms. As new technologies and pedagogical approaches are thus 'blended' with the traditional classroom setting, some even claim that HE in the future will be entirely based online.[6] While current evidence suggests that such predictions remain far from being realised, it is undeniable that an increasing amount of education is taking place online.

Blended learning

Blended learning combines face-to-face and online modalities to generate an enhanced, more flexible, learning experience and potentially greater academic achievement than courses that are exclusively one-format.[7] Educators can track student success and incorporate feedback into a more tailored learning program.[8] One form of blended learning - virtual laboratories - allows students to transgress the limitations of a physical learning space and to repeat simulated experimentations without risk or constraint.[9] Alternatively, one version of the 'flipped classroom' reverses the lecture/homework custom of a course and

---

1 Johnson, et al., "NMC Horizon Report: 2016 Higher Education Edition." 2016, goo.gl/d3dbsu.
2 Ibid p. 6.
3 High Level Group,"High Level Group on the Modernisation of Higher Education." 2014, goo.gl/np12Y7.

4 Ibid p. 10.
5 Ibid p. 14.
6 Ibid p. 15.
7 Johnson, et al., "NMC Horizon Report: 2016 Higher Education Edition." p. 18.
8 Sharpe., Benfield. "The Student Experience of E-learning in Higher Education: A Review of the Literature." 2005, goo.gl/YksAUZ.
9 Johnson, et al., "NMC Horizon Report: 2016 Higher Education Edition." p. 18.

allows students to apply their work to practical tasks online.[10]

The innovation of blended learning is being backed by Google, which, through its Computer Science Capacity Awards program, is funding eight universities over the course of three years to test the boundaries of blended pedagogy.[11] Similarly, Reimagine Education offers an e-Learning Award to entrants who submit a project utilising existing electronic learning tools in an innovative way.[12] Last year's winner, BioBeyond, which uses both online and blended modalities, aims to improve learner success in entry-level Biology for disengaged students.[13] Rather than starting the courses with a syllabus and specific objectives, students are encouraged to use 'big questions' as a hook.[14] This portrays how the student can become an active participant in his/her own learning experience.

According to Fawn and McKenzie, this process is "*facilitating an identity shift and creating a safe space to practice skills that can be adjusted to suit the needs of the learner*".[15] As students develop a new 'learner identity', the lines between teacher and student can blur and become more collaborative. This is an example of how technology can help to put 'students at the heart' of their learning experience - a goal pursued by a number of UK universities a few years ago, in an attempt to improve student experience.[16]

Augmented reality and virtual reality

Reality can also blend with educational tools. Augmented reality (AR), or 'blended reality', refers to the 'layering of data over 3D spaces' to enhance a participant's encounter with reality.[17] AR can be built into apps on mobile phones to blend the digital and real world, but in such a fashion that they remain distinct from one another.[18] Diversely, virtual reality (VR) simulates changes to the physical environment through audio, and visual embodiments of people and objects.[19] AR and VR are increasingly being developed into viable tools within the HE sector, generating some of the most stimulating pedagogical innovation of the 21st century.

VR is made possible at low cost through virtual headsets attached to smart phones, simulating visual experiences.[20] Google Cardboard has enabled the spread of this tool in HE. Alternatively, VR simulation rooms can provide complex training, like that used for astronauts.[21] Furthermore, VR has a lot of potential for online education. MIT and Stanford University have

10 Ben Hamida et al., "The Pedagogical Innovation Serving Technological Education." 2016, goo.gl/51hFMU. p. 25.
11 Johnson, et al., "NMC Horizon Report: 2016 Higher Education Edition." p. 19.
12 Reimagine Education, "E-Learning Award." QS, goo.gl/dauKrS.
13 Ibid.
14 Ibid.
15 Fawns., McKenzie, "Elearning, Communities of Practice and Internationalization.." 2011, goo.gl/LTjwcJ.
16 Government Report, "Success as a Knowledge Economy: Teaching Excellence, Social Mobility and Student Choice." 2016, goo.gl/8DfgAm.

17 Johnson, et al., "NMC Horizon Report: 2016 Higher Education Edition." p. 40.
18 Augment. "Virtual Reality vs. Augmented Reality." 2015. goo.gl/HWYBre.
19 Johnson, et al., "NMC Horizon Report: 2016 Higher Education Edition." p. 40.
20 Ibid.
21 Ibid.

adopted VR into their executive education programs, enabling students from all over the world to partake in a simulated on-campus environment, so they can network and conduct group work.[22]

AR is particularly relevant for students who cannot experience specific conditions untrained, which is why AR, alongside VR, has revolutionised the medicine discipline.[23] City University London ran a project which offered nurses simulated clinical training, by emulating patient care scenarios.[24] AR is also applied frequently to visual subjects such as architecture, engineering and construction, and music production, demonstrating AR's versatility as an educational tool.[25]

The pedagogical implications of Adaptive Learning

Adaptive Learning (AL) is a tailored pedagogy designed to meet the needs of individual students.[26] The learner is thus entering a more 'personalised learning' environment, which is again demonstrative of the 'active learner'.[27] This empowers students to dictate the parameters of their learning experience, as opposed to traditional teaching methods in which they play a more passive role.

Adaptive approaches can be defined by two main categories: 'facilitator-driven' and 'assessment driven'. Both can be found within the same teaching model.[28] The difference relates to that which is acted on by the instructor (facilitator-driven) and that which adjusts itself independently (assessment-driven).[29] Both these

methods collate data to monitor student progress, and adapt courses to individual requirements.[30] The objective 'is to build better pedagogies, empower active learning, target at-risk student populations, and assess factors affecting completion and student success'.[31]

Adaptive Learning: machine learning technologies

Examples of AL include the use of mobile cloud computing as a platform to deliver adaptive multimedia learning.[32] Coordinated visual/verbal multimedia content can be streamed to mobile phones, according to student preference and network capabilities.[33] Device limitations can block this as a viable AL method, as not all phones are able to process the content being uploaded.[34]

Another mode of delivery is the use of AL robots.[35] Robotic agents can monitor student concentration in real time using EEG brain activity monitoring, brain computer interfaces and educational psychology techniques.[36] Robots respond to distracted students by employing 'immediacy clues' including gestures, raising vocal levels and smiling to refocus them.[37] A study examining this method reported a 43% increase in overall recall ability, whilst female students displayed an extremely positive response.[38] This illuminates the potential of machine learning technologies, which 'are now capable of learning the way people learn'.[39]

22 Ibid.
23 Ramirez, "Augmented Reality in Higher Education: Five Tips to Get Started." Times Higher Education, 2015, goo.gl/d2g1Ua.
24 Ramirez, "Augmented Reality in Higher Education."
25 Johnson, et al., "NMC Horizon Report: 2016 Higher Education Edition."
26 Waters, "Adaptive Learning: Are We There Yet?", The Journal, 2014, goo.gl/2gvjhH.
27 Fawns., McKenzie, "Elearning, Communities of Practice and Internationalization.."
28 Waters, "Adaptive Learning: Are We There Yet?"
29 Ibid.

30 High Level Group,"High Level Group on the Modernisation of Higher Education."
31 Johnson, et al., "NMC Horizon Report: 2016 Higher Education Edition." p. 38.
32 Karadimce., Davcev, "Adaptive multimedia learning delivered in mobile cloud computing environment." ThinkMind, 2013, goo.gl/UEG4xw.
33 Ibid.
34 Ibid.
35 Szafir., Mutlu, "Pay attention!: Designing Adaptive Agents that Monitor and Improve User Engagement." 2012, goo.gl/wrFFe4.
36 Ibid.
37 Ibid.
38 Ibid.
39 Johnson, et al., "NMC Horizon Report: 2016 Higher Education Edition." p. 38.

Adaptive Learning: microlearning

Microlearning is the modern-day solution to the short attention spans of today's learners. A combination of excessively digitised life-styles, smart phone addictions and easily accessible entertainment, have, according to some critics, created a generation of inattentive youth. However, a recent study shows this to be endemic throughout society, with the average person having an attention span shorter than that of a goldfish, at just eight seconds.[40]

Microsoft found that since the year 2000 there has been a four-second decline in the attention span of survey participants, a finding they attributed to evolution; the human brain is adapting to the mobile internet.[41] This is where microlearning steps in, providing bite-sized chunks of learning content at just three to seven minutes, thereby accommodating the constraints of the 21st century brain.[42] Teaching new age learners therefore involves catering to this evolving reality. Traditional pedagogy, such as a one or two hour lecture, may seem increasingly old-fashioned as we step deeper into the information age.

Microlearning can be the perfect addition to an AL model. AL programs are designed to adapt to the learner, providing extra content according to a student's performance and rate of completion.[43] This blends well with microlearning, in which smaller chunks of content can be delivered to fast learners, rather than an overload of new information.[44] Microlearning units can fill any 'knowledge gaps' a student may have, offering short bites of content that attend to the learner's specific weaknesses.[45]

Adaptive Learning: university implementation

The Open University now uses algorithms to monitor particular students and their level of commitment to the course.[46] Teachers can view data which analyses a student's individual history related to factors like their engagement with the online platform and the amount of reading material they've accessed.[47] This allows teachers to respond to students who are falling behind, potentially creating a more personalised approach.

Arizona State University has partnered with Knewton and Pearson to implement a new AL model in developmental Math, which has resulted in enhanced student performance in comparison to the traditional program.[48] Such a result is not uncommon, and a growing body of research supports the application of AL.[49] For example, Nakic, Granic & Glavinic (2015) maintain that AL can "*improve student retention, achieve higher course outcomes, and provide a more precise measure of learning*".[50]

40 McSpadden, "You Now Have a Shorter Attention Span Than a Goldfish."Time, 2015, goo.gl/d3NjRi.
41 Ibid.
42 Singh, "17 Awesome Resources on Micro-Learning." eLearning Industry, 2014, goo.gl/iH6CKg.

43 Growth Engineering, "What Is Microlearning?" 2016, goo.gl/o6A1P7.
44 Ibid.
45 Ibid.
46 Johnson, et al., "NMC Horizon Report: 2016 Higher Education Edition." p. 39.
47 Ibid.
48 Ibid. p.38
49 Dziuban et al., "Adaptive Learning: A Tale of Two Contexts." 2017, goo.gl/FFtKKH.
50 Ibid.

Trends, cultures and challenges shaping pedagogical innovation

In 2016, the New Media Consortium (NMC) Horizon Report forecasts the trends that will advance pedagogical innovation over the next decade.[51] 'Bring Your Own Device' and AL are expected to, and have, become increasingly popular, drawing on mobile learning and online student data to enhance the learner experience.

It is anticipated that augmented and virtual reality will experience more widespread adoption over the next two years.[52] Similarly, makerspaces, which provide communal access to supplies and devices like 3D printers, are estimated to follow the same 'time-to-adoption' as AR and VR.[53] According to the NMC report authors, makerspaces 'mirror the sharing economy trend that has disrupted the transportation and hotel industries' and is similarly expected to shake up HE.[54]

A future in which robots work alongside students is no longer just the hyperbole of sci-fi movies. Robotics, too, is projected to become more prevalent in mainstream HE within the next three to four years.[55] This is unsurprising, given reports that by 2050 the 'global robot population' will double to four million.[56] Robotics has shown particular promise for medical education. Medical students at the University of Mexico, for instance, can operate on robots with synthetic blood, mechanical organs and simulated respiratory systems.[57] Dr. Nancy W. Gleason, who is a Director at the Centre for Teaching and Learning and Senior Lecturer within the Social Science Division at Yale-NUS College, writes about the way in which machine learning technologies will shape HE in the coming years.

---

51 Johnson, et al., "NMC Horizon Report: 2016 Higher Education Edition."
52 Ibid.
53 Ibid. p. 1.
54 Ibid. 41.
55 Johnson, et al., "NMC Horizon Report: 2016 Higher Education Edition." p. 46.
56 Ibid.
57 Ibid p. 47.

"In the fourth industrial revolution there will still be demand for employees who have completed an undergraduate degree. But constantly re-skilling those graduates will be equally important," Gleason contended.

"The job of the professor will change. Professors, like everyone else, will have to constantly be learning how to use and communicate with those who use new technologies. Students will collect information in new ways; some of this will be complemented by artificial intelligence and online learning."

Below are Dr. Gleason's projections for the ways in which the structures of HE will be changed by the fourth industrial revolution.

In terms of the way HE institutions operate:

- HE institutions will have to vigorously compete in the credentialing economy. Adult and younger learners will need to integrate more in their classrooms and curriculums.

- There will be a significant economy for up-skilling due to the need for adult learners to adjust to fast-paced changes in labor demands.

- Artificial intelligence will replace administrative staff. The newly-available revenue will provide investment opportunities like lower tuition, increased financial aid, upgraded facilities, or the development of a new, innovative curriculum for the future economy.

What HE institutions offer their students:

- Information transfer is no longer the sole function of HE. Institutions have to create critical thinkers who can problem-solve in a constantly-changing work environment.

- Content is important, but more important is what institutions do with it. Cultivating minds capable of constantly learning is essential for the nurturing of long-term employability, something many HE institutions under-deliver despite high tuition fees.

- Holistic education institutions that offer curricula yielding lifelong learners will thrive, while those who do not, won't.

Challenges

Ethical considerations must also be accounted for. Monitoring student data is characteristic of adaptive learning methods, but has raised privacy concerns, alongside fears about the security of student data.[58] Moreover, despite the purported benefits of adaptive learning, its implementation around the world has been 'uneven', with some regions, such as Australia, for example, approaching less quickly than other regions the area of learning analytics.[59]

Furthermore, many employers feel graduates are not equipped with the skills to successfully navigate the current employment market, suggesting institutions are not adequately preparing them.[60] This 'skills-gap', which we explore more thoroughly in the Graduate Skills -Gap & Graduate Employability section of this whitepaper, could be related to the 'powerful barriers' which a 2016 OECD report claimed are stopping 'digital technologies from reaching their potential in educational institutions'.[61]

Striking a balance between students' 'connected and unconnected lives' has been recognised as a much more complex challenge.[62] Baylor University found that students spend between eight to ten hours daily on their smart phones, and will admit to having become too dependent.[63] Such challenges are being tackled by new pedagogical frameworks - such as the Substitution, Augmentation, Modification, and Redefinition (SAMR) Model (developed by Dr Ruben Puentedura), which attempts to safeguard the purposeful use of technology.[64] Nevertheless, technology is providing an answer to diversity challenges by making HE more accessible.[65] The exclusivity of HE had been tackled by online technology, which has opened doors that were previously closed.[66] An increased number of people can 'learn anywhere, anytime and from anyone'.[67]

The more HE sectors learn how to effectively and ethically harness the vast potential technology offers, the greater potential exists for change, progress and pedagogical innovation.

---

58 Ibid p. 39.
59 Johnson, et al., "NMC Horizon Report: 2016 Higher Education Edition." p. 39.
60 Ibid p.32.
61 Ibid p.19.
62 Ibid p.1.
63 Ibid p. 30.
64 Ibid p. 30.

65 High Level Group,"High Level Group on the Modernisation of Higher Education." p. 10.
66 Ibid.
67 Ibid.

CASE STUDY

USC Institute for Creative Technologies

University of Southern California's Institute for Creative Technologies

Described by the University of Southern California (USC) as a 'neutral ground for a marriage of Hollywood and high technology,' the Institute for Creative Technologies (ICT) explores human-computer interaction through virtual reality, including simulated scenarios, video games and virtual characters.[1] The technology cultivated in the experimental virtual reality lab can be found in a variety of settings, as versatile as simulated army training environments, Hollywood movies like Avatar, and realistic virtual humans that, for example, can enable young adults with autism to practice job interviews.[2]

In 1999, the US army entered a US$ 43M contract with USC to erect the institute, and in 2004 the grant was renewed for a further US$ 100M.[3] Whilst the objective was to build highly advanced technological tools to facilitate army training, the technology was designed to further advance video games, film and television.[4]

ICT takes a multidisciplinary approach, combining computer science, psychology, interactive media and other departments to advance immersive technologies to improve interactions and learning in a wide range of areas.[5] The researchers believe the findings can inform the understanding of human behaviour through the study of people's interactions and responses to virtual characters and technology. According to USC "ICT aims to literally change the face of computing".[6]
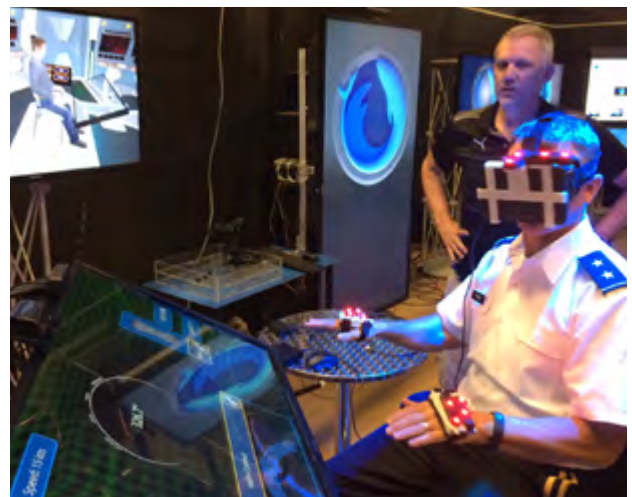

Image copyright© of USC Institute for Creative Technologies

1 Robertson, "Inside USC's crazy experimental VR lab." The Verge, 2015, goo.gl/PSYmMZ.
2 Ibid.
3 Ibid.
4 Ibid.

5 University of Southern California,"Research Overview", USC Institute for Creative Technologies, http://ict.usc.edu/research/.
6 Ibid.

BIBLIOGRAPHY

Government Report, "Success as a Knowledge Economy: Teaching Excellence, Social Mobility and Student Choice." *Presented to Parliament by the Secretary of State for Business, Innovation and Skills*, by Command of Her Majesty. May. 2016, goo.gl/8DfgAm. Accessed on 30 October 2017.

Augment. "Virtual Reality vs. Augmented Reality." *Augment*, 6 October. 2015. goo.gl/HWYBre. Accessed 2 October 2017.

Ben Hamida, S., Maaloul, A., & Ben Hamida, S. "The Pedagogical Innovation Serving Technological Education." *Creative Education*, 2016, Vol. 7, 2016, pp. 20-31. goo.gl/51hFMU. Accessed 2 October 2017.

Dziuban, Charles., Moskal, Patsy., Johnson, Constance., Evans, Duncan., "Adaptive Learning: A Tale of Two Contexts." *Current Issues in Emerging eLearning*, Vol. 4, Iss. 1 , Article 3. 8 March. 2017, goo.gl/FFtKKH. Accessed 2 November 2017.

Fawns, Tim., McKenzie, Karen. "Elearning, Communities of Practice and Internationalization: Presentation Delivered at the Joint HEA/UKCISA." *Higher Education Academy*, 16th and 17th June. 2011, goo.gl/LTjwcJ. Accessed 2 October 2017.

Growth Engineering, "What Is Microlearning?" *Growth Engineering: Online Learning Glossary*, 7 October. 2016, goo.gl/o6A1P7. Accessed 25 September 2017.

High Level Group. "High Level Group on the Modernisation of Higher Education." *European Commission Report to the European Commission on New Modes of Learning and Teaching in Higher Education*, Luxembourg: Publications Office of the European Union, Oct. 2014, goo.gl/np12Y7. Accessed 2 October 2017.

Johnson, L., Adams Becker, S., Cummins, M., Estrada, V., Freeman, A., and Hall, C. "NMC Horizon Report: 2016 Higher Education Edition." *Austin, Texas: The New Media Consortium*, 2016, goo.gl/d3dbsu. Accessed 6 September 2017.

Karadimce, A. & Davcev, D. "Adaptive multimedia learning delivered in mobile cloud computing environment." *ThinkMind*, *CLOUD COMPUTING 2013, The Fourth International Conference on Cloud Computing, GRIDs, and Virtualization*, 27 May. 2013, pp. 62–67. goo.gl/UEG4xw. Accessed 2 November 2017.

McSpadden, Kevin. "You Now Have a Shorter Attention Span Than a Goldfish." *Time*, 14 May. 2015, goo.gl/d3NjRi. Accessed 2 October 2017.

QS, "Reimagine Education: The Awards." *Reimagine Education*, 2017, http://www.reimagine-education.com/awards/. Accessed 9 September 2017.

R Sharpe, G Benfield, "The Student Experience of E-learning in Higher Education: A Review of the Literature." *Brookes eJournal of Learning and Teaching*, Vol. 1, Issue 3, Oct. 2005, goo.gl/YksAUZ. Accessed 2 October 2017.

Ramirez, Matthew. "Augmented Reality in Higher Education: Five Tips to Get Started." *Times Higher Education*, 5 March. 2015, goo.gl/d2g1Ua. Accessed 2 October 2017.

Robertson, Adi. "Inside USC's crazy experimental VR lab." *The Verge*, 17 September. 2015, goo.gl/PSYmMZ. Accessed 2 November 2017.

Singh, Ravi Pratap. "17 Awesome Resources on Micro-Learning." *eLearning Industry*, 11 May. 2014, goo.gl/iH6CKg. Accessed 2 October 2017.

Szafir, D., Mutlu, B. "Pay attention!: Designing Adaptive Agents that Monitor and Improve User Engagement." *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 2012, pp. 11–20. goo.gl/wrFFe4. Accessed 2 November 2017.

University of Southern California, "Research Overview." *USC Institute for Creative Technologies*, http://ict.usc.edu/research/. Accessed 2 November 2017.

Waters, John K. "Adaptive Learning: Are We There Yet?" *The Journal*, 14 May. 2014, goo.gl/2gvjhH. Accessed 25 September 2017.

ABOUT QS

Established in 1990, QS is dedicated to providing independent and authoritative research and resources for both prospective students and higher education providers worldwide. The QS World University Rankings®, published annually since 2004 and hosted on student-focused platform TopUniversities.com, is among the most-consulted resources in the sector.

QS Intelligence Unit (QSIU) was formed in 2008 in response to growing public demand for comparative data on universities and other higher education providers, and for institutions to develop deeper insight into their competitive environment. Committed to the key values of rigorous integrity, undeniable value, unique insight and charismatic presentation, QSIU strives to be the most trusted independent source of global intelligence on the higher education sector.

In addition to the research and insights provided by QSIU, QS offers a range of services to help prospective international students find the right institution – and vice versa. This includes a global series of higher education fairs; an annual publication cycle of guides, reports and e-papers; and a dynamic range of online platforms.

TRUSTED · INDEPENDENT · GLOBAL