4th Industrial Revolution(4IR)for Smart Learning

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Introduction:

This paper provides an assessment of how 4IR revolutions have impacted Smart education. It develops technical capacity in emerging technologies in active and project-based settings. The societal changes from the 4IR will require education to develop greater capacity for ethical and intercultural understanding, placing a premium on liberal arts-type education with modifications to adapt to the particular issues raised by 4IR technologies and their disruptions to society. It requires a rapid adjustment of curriculum by expanding its capacity to accommodate the acquisition of new knowledge by students, faculty and alumni, with new modalities of instruction that leverage the digital advances from the Third Industrial Revolution.

The Fourth Industrial Revolution (4IR) is a concept widely discussed at venues such as the World Economic Forum (WEF) at Davos and within business leadership. Recent white papers describe how the 4IR will "shape the future of education, gender and work [1] and how the 4IR will require "accelerating workforce reskilling [2] [3] .

The Third Industrial Revolution, which is generally attributed to computerization and web-based interconnectivity developed in the 1980s and

1990s, is only now having its rippling effects upon society, politics, economics and education. Within the Third Industrial Revolution, the expansion of access to higher education rose to even greater prominence with greatly increased diversity on campuses and globalization of academic research accelerated by online technologies. An intensive commitment to large-scale higher education across the world has resulted in increasing rates of participation in higher education in India, China as well as the United States.

One of the largest ripples from the Third Industrial Revolution was the move toward online education, which culminated in the "Year of the MOOC" during 2012 as massive online open courses were expected to completely displace traditional in-person higher education and expand access to university education to millions of previously unserved students across the world. The revolution of higher education brought about by online courses is still ongoing, but is more likely to result in an integration of high quality, synchronous, in-person learning environments with online technologies to enable students to more rapidly build skills and knowledge asynchronously. One author has suggested a useful framework of higher education activities between those that are intrinsically synchronous and personal, such as personal exploration, coaching and mentorship, from those activities that can be easily scaled and shifted online such as content transfer, and authoring and production[4]Within the environment of increasing online content delivery and access to information, these more personal and "high-touch" components of the educational experience will become of increasing value and will not be easily replaced by technology. Online and tech-enhanced teaching within universities is enabling both research universities and liberal arts colleges to more efficiently teach students with diverse backgrounds, and to open up their campuses to a more global community of both faculty and students. Small liberal arts colleges are working together to realize economies of scale with new

types of technologies that improve on-campus experience for students through online math courses for incoming students, language.

The societal changes from the 4IR will require higher education to develop greater capacity for ethical and intercultural understanding, placing a premium on liberal arts-type education with modifications to adapt to the particular issues raised by 4IR technologies and their disruptions to society.

The 4IR often is described as the result of an integration and compounding effects of multiple "exponential technologies," such as artificial intelligence (AI), biotechnologies and nanomaterials. One example of the emerging reality within the 4IR is the development of synthetic organisms (life from DNA created within computers and bio printed) manufactured using robotic assembly lines, where nanomaterials provide immense improvements in the efficiency of production. The 4IR extends the paradigm of industrial revolution into a future when many of the elements of what we might consider industry—Axed and centralized factories, massive labor forces within large corporations—will no longer exist. The most familiar exponential technology is the exponential increase in computer power and decreasing cost in storage, which obeys a geometric relation commonly known as Moore's Law. The doubling of CPU power.

A useful framework of disaggregating higher education activities between those that are intrinsically synchronous and personal, such as personal exploration, coaching and mentorship, from those activities that can be easily scaled and shifted online such as content transfer, and authoring and production. Within the environment of increasing online content delivery and access to information, these more personal and "high-touch" components of the educational experience will become of increasing value and will not be easily

replaced by technology. the technologies of the 4IR will become widespread enough to create massive societal change. These tipping points include the proliferation of 4IR technologies to levels where they make significant impacts on our lives and require shifts in employment and education. Examples include implantable cell phones by 2025, 80% of people with a digital presence by 2023, 10% of reading glasses connected to the internet by 2023, 10% of people wearing internet-connected clothes.

Online and tech-enhanced teaching within universities is enabling both research universities and liberal arts colleges to more efficiently teach students with diverse backgrounds, and to open up their campuses to a more global community of both faculty and students. Small liberal arts colleges are working together to realize economies of scale with new types of technologies that improve on-campus experience for students through online math courses for incoming students, language courses taught via videoconferencing, and new ways of merging social media with small-class seminars. One example of an initiative of this sort is the Liberal Arts Consortium for Online Learning (LACOL), which has brought together some of the leading US liberal arts colleges to explore these technologies[5] Online education companies such as Coursera and EdX are partnering with larger universities to create newer and more interactive formats for their online courses and are developing dozens of new “stackable micro-credentials [6] that link multiple online courses with in-person consultations with faculty and opportunities for students to conduct significant original capstone projects.

The Third Industrial Revolution has brought educators to an environment where access to information is immediate and free, shifting the focus toward active learning pedagogies that place a premium on collaboration within diverse teams in a project-based and peer learning environment [7]. Many of the most

thoughtful responses to reform in STEM education in recent years have resulted in a greater emphasis on liberal arts and inter-personal skills imbedded within a more interdisciplinary curriculum. Examples include the Project Kaleidoscope Science initiative, [8]Liberal Studies in Engineering [9],the American Physical Society SPIN-UP project [10] and the HHMI Scientific Foundations for Future Physician report [11].All emphasize more interdisciplinary approaches in STEM that develop student capacity for collaboration and social interaction within STEM courses and curriculum.

The WEF has defined a set of tipping points at which the technologies of the 4IR will become widespread enough to create massive societal change. These tipping points include the proliferation of 4IR technologies to levels where they make significant impacts on our lives and require shifts in employment and education. A survey of 800 high-tech experts and executives determined a series of dates by which tipping points would be reached. Examples include implantable cell phones by 2025, 80% of people with a digital presence by 2023, 10% of reading glasses connected to the internet by 2023, 10% of people wearing internet-connected clothes Larger-scale responses in recent years to changing realities in the world have also resulted in entirely new institutions created with more global and more interdisciplinary curricula and a greater emphasis on strong collaborations between students within a residential community. Yale-NUS College in Singapore offers an inter-disciplinary curriculum which features literature and philosophy from both Eastern and Western cultures, a range of interdisciplinary science courses and quantitative reasoning, and courses in Modern Social Thought and Comparative Social Inquiry that enable students to collaborate and discuss some of the deepest issues of identity, family and social responsibility within the emerging globalized world of the twenty-first century[12]. A remarkable curriculum at Soka University of America in

California develops students to become “global citizens” through intensive language study and required study abroad in a foreign language, as well as with wide-ranging core courses that explore “Enduring Questions” of humanity and how these questions are answered in a social context, drawing from classic works of Chinese, Indian and Greek philosophers, European social theorists and modern interpretations of twenty-first-century society in both the US and Asian contexts. Courses in both American Experience and the Pacific Basin and Modes of Inquiry further develop student capacity for discussion, dialogue and rejection within an international context [13]. A third curriculum being developed by Duke University for its new Duke-Kunshan University in China explores the concept of “rooted globalism,” and blends an appreciation for a local culture with an exploration of international approaches to identity and society, and develops a framework for liberal arts in China in the twenty-first century[14].

The exact impacts of such 4IR technologies on society and the planet arestill unknown—but the fact that they will bring profound and rapid change seems all but certain. The need for higher education to respond is urgent as the power of 4IR technologies for either positive social impacts or devastating environmental damage is upon us, as is the potential for irreversible loss of control over networks of powerful AI agents with increasing autonomy within financial sectors and within urban infrastructure. Substantial changes to the science and technology curriculum will be Required to allow for students to develop capacity in the rapidly emerging areas of genomics, data science, AI, robotics and nanomaterials. Such a 4IR STEM curriculum would reconsider the curriculum within the traditional “primary” sciences—biology, chemistry and physics—and place a higher premium for training in computer science subjects as a form of 4IR literacy.

Any educational plan for the 4IR must be built upon the results of the Third Industrial Revolution described earlier, with its emerging development of hybrid online and in-person instruction, and efficient and seam-less integration of global videoconferencing and a wide array of asynchronous educational resources. Blended instruction and optimization of flipped and online courses will make more efficient learning environments that can adapt for diversity in preparation of students.

Any effective 4IR education strategy must also include in equal mea-sure a deep consideration of the human condition, the ways in which new technologies and shifting economic power impact people of all socio-economic levels, and the threats that exist within a world that is increasingly interconnected, in a way that fosters deep intercultural understanding and an abiding respect for freedom and human rights. Such approaches

favor an interdisciplinary and global curriculum in a residential context, such as is found in many liberal arts institutions. These approaches maximize the development of intercultural and interpersonal skills, which will be a hallmark of the future 4IR workplace.

1. Environmental trends influencing a ‘campus master plan’ strategy and design

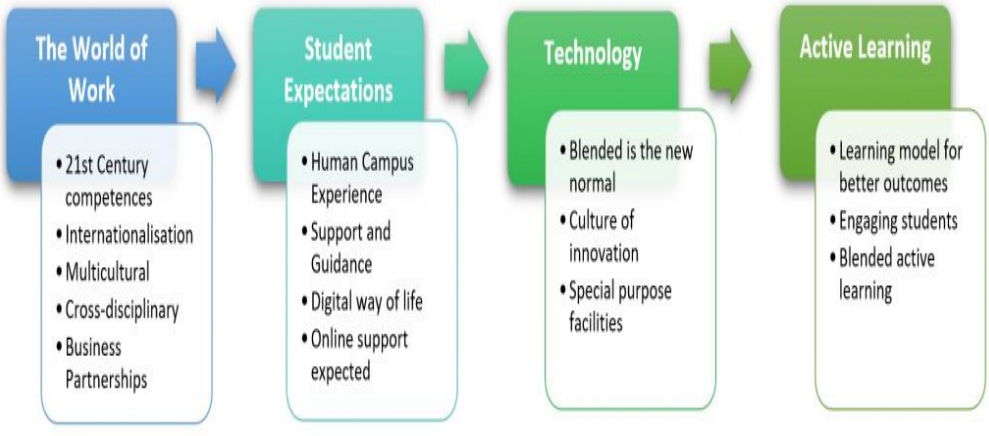

Figure1, : Environmental trends influencing a ‘campus master plan’ strategy and design

Technology is changing the face of society, the workplace and education, yet few higher education institutions are offering the high quality digitally supported course experiences and related services to full-time campus-based, part-time or distance students that are possible. Innovation in pedagogy, learning spaces and in the application of technology is essential to provide high quality offerings, flexibility for different needs, and a more dynamic education system.

New technologies are constantly pushing boundaries enabling active and instrumented learning spaces, new maker spaces, blended synchronous learning, augmented and virtual reality environments, design labs and fabrication facilities. These are bringing new thrilling and flexible dimensions to the learning and exploration process, yet supported innovation in these advanced approaches is not yet entering the main-stream process. In the medium-term these approaches will create new opportunities and advances but lack of support for innovation will put institutions at risk of competition from more innovative and agile institutions or learning services. Institutions need to create a strong university platform on which faculties can innovate and develop a stronger set of services.

A progressive and future-proof campus framework designed for 21st Century students, academics and administrators helps define and design active learning spaces and a high quality on-campus experience, together with a consistent high-quality digital environment, and a virtual campus experience which carries the strong institutional identity of a leading university across campus, campus and to distance learners globally.

2. Seven categories of recommendations to future-proof higher education

All of these aspects have an important relationship with the technology strategy of the institution, the quality of technology and learning spaces offered, and the quality of digital, online and virtual experiences offered. Cohesive and

coherent learning models across all learning environments are key to the success of a hybrid learning model. The physical and virtual learning space design should be complementary. In our research and analysis we developed seven categories of recommendations to help future-proof higher education institutions for the 21st Century (Figure 2).

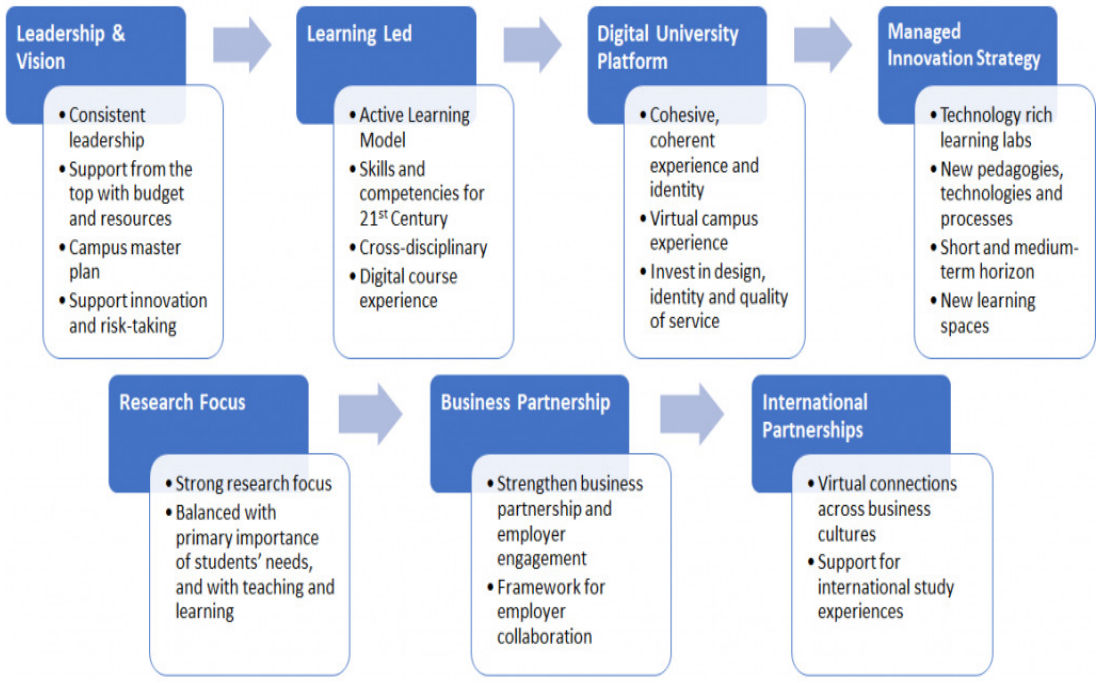

Figure 2: Seven categories of recommendations to future-proof higher education

In the leading institutions interviewed and visited for this research, blended learning is the new normal. The recommendations apply equally to campus-based and virtual digital higher education. The most competitive institutions are offering students a rich mixture of campus based, digital and distance experiences.

3. Case study : Global University System (GUS)

The use of the modern digital telecommunications, will be needed to create mutual understanding among nations, cultures, ethnic groups, and

religions. GUS is a worldwide initiative to create advanced telecom infrastructure around the world for global e-learning and e-healthcare/ telemedicine. The philosophy of GUS is based on the belief that global peace and prosperity would only be sustainable through education. Education and job skills are the keys in determining a nation's wealth and influence. The aim is to achieve "education and healthcare for all," anywhere, anytime and at any pace. GUS helps higher educational and healthcare institutions in remote/rural areas of developing countries to deploy broadband Internet in order for them to close the digital divide. These institutions act as the knowledge center of their community for the eradication of poverty and isolation through the use of advanced Information and Communications Technologies (ICT). Learners will be able to take their courses from member institutions around the world to receive a GUS degree, thus freeing them from being confined to one academic culture of a single university or country. Learners and their professors from participating institutions will also form a global forum for exchange of ideas and information and for conducting collaborative research and development with the use of emerging GRID networking technology.

GUS has group activities in the major regions of the globe in partnership with higher learning and healthcare institutions. They foster the establishment of GUS in their respective regions, with the use of an advanced global broadband Internet virtual private network. These will then connect the universities with secondary and elementary schools, libraries, hospitals, local government offices and NGOs, etc., by broadband wireless Internet at drastically discounted rates (Figure 3).

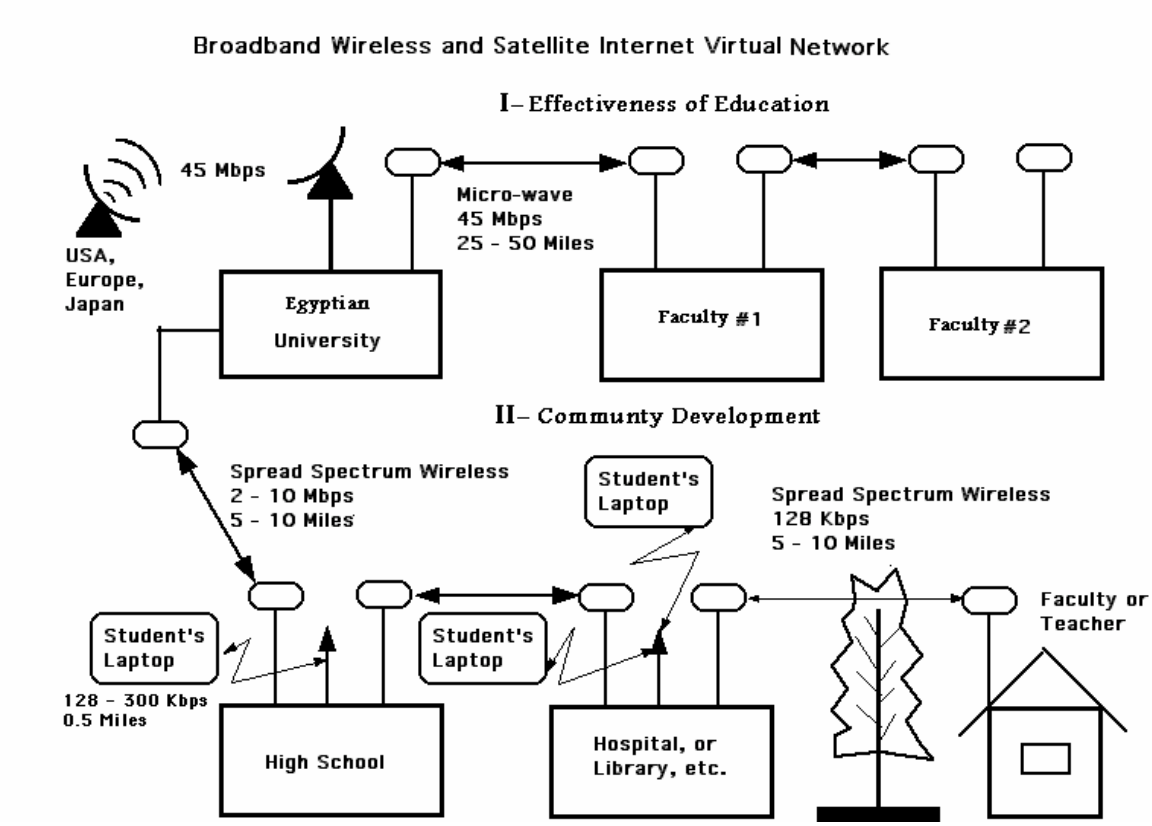

Figure 3. Broadband wireless and satellite Internet virtual network

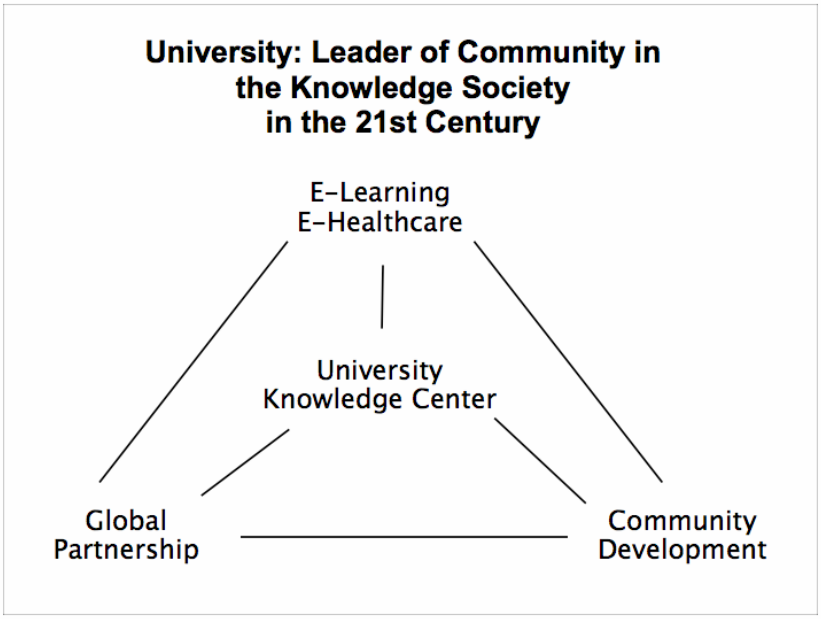

Figure 4: University as Leader of Community

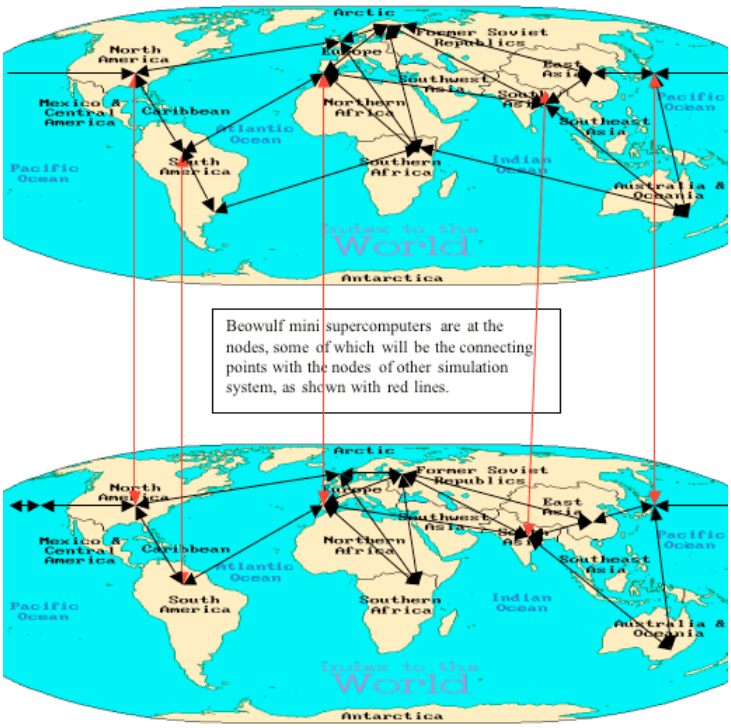

Figure 5: Globally Collaborative Environmental Peace Gaming (GCEPG)

This Model will then demonstrate integrated and synergistic approach among grassroots, government, university, stakeholder, etc. Use of graphic info modeling/mapping and potential "gaming" on key issues and solutions will assist each group's ability for standardized data gathering and situational analyses, projecting out possible outcomes for more informed decision making and activities. It brings together most sophisticated university-based mathematical modeling techniques and experts and regular people who can then more easily see--at a glance--how issues and outcomes can impact and interact each other.

Conclusions

The first three industrial revolutions provided evidence for the profound shifts in society, the economy and education which resulted in a proliferation of curricular innovation and the establishment of new educational institutions. As in the previous three industrial revolutions, the most pro-found effects of the 4IR

on our society will not be realized for many decades. Unlike previous industrial revolutions, however, the 4IR features the impacts of several compounding exponential technologies which all share the capacity for rapid increases in scale and reductions of cost. This rapidity of advance in technologies demands a more proactive response from the educational sector than the more gradual societal evolution and subsequent response from educational institutions in earlier industrial revolutions. The impacts of the emerging 4IR technology in economic and environ-mental terms alone will require a drastic reconsideration of the curriculum within higher education to enable students both to comprehend the indi-vidual technologies in detail and to be able to thoughtfully analyze and predict the evolution of networked systems of technology, the environ-ment and sociopolitical systems. The dynamic responses with networked systems and exponential feedback effects will amplify the pace of change, as has already been seen in the context of global climate change and in many other physical and biological contexts. The 4IR STEM curriculum will need to focus on emerging technologies—robotics, AI, IoT, nanomaterials, genomics and biotech—to provide a workforce not only capable of developing new applications and products, but also capable of interpreting the effects of these technologies on society and using their training to provide sustainable and ethical uses of science and technology. More than any particular content area, curriculum needs to help students develop the capacity for ethical reasoning, for awareness of societal and human impacts and to be able to comprehend the impacts of 4IR technologies on people, so they are trained to not only increase our material prosperity but also to improve our social and cultural fabric. From strictly economic terms, students who are capable of creative insights, collaborating in diverse teams, and navigating through global cultural differences will be at an advantage in a workplace where the meaning of skills will become more of interpret-ing rapidly changing information and being able to work with experts and stakeholders toward common understanding of the

benefits of sustainable development. While earlier industrial revolutions have prioritized some of the raw materials needed to fuel their factories or cities—placing a pre-mium on capital based in physical resources such as land, water power, coal, oil and wood—the 4IR will place a premium on intellectual capital and in capacity for collective thought. Students who are able to learn in residential environments with diverse colleagues and develop solutions together in teams will be well trained for the types of tasks that will be asked of them in the 4IR.倩Our colleges and universities owe it to these students and our future to develop more interactive forms of pedagogy at all levels and to embrace a curriculum that stresses perspectives from multiple disciplinary and cultural perspectives over static swathes of disciplinary "content." Many of the emerging liberal arts institutions in the United States and Asia and new types of CTE curricula are providing useful exam-ples of how to implement this new model of 4IR higher education. Higher education needs to recognize the necessity of adapting and scaling up these new 4IR forms of education rapidly to assure the sustainability of our environment and economy, as well as to sustain the relevance of higher education as a responsive and vital component of society. Taken together, these new forms of 4IR education will prepare both students and faculty for leadership roles in a world of rapidly accelerating change, with a cur-curriculum that develops both technical mastery and a deep awareness of ethical responsibility toward the human condition.

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