

The Future of Learning: Transforming Education in the digital era

The format and productivity of education provision have been largely unchanged over the past 100 years. In our view, a confluence of factors will transform who and what is taught, and how and where, as well as the productivity of education delivery in the coming years. The physical convening of students has been the biggest impediment to scaling education to date, but we believe that learning can migrate from a capital- and talent-intensive bricks & mortar business model into one fit for the digital era.

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Portfolio Manager summary

We forecast global education spend to grow at a CAGR of 4.9% in 2018-30, reaching \$18.9 tn by 2030.

Our estimate of Global Education spend is made up of Government Spend (63.2%), Household Spend (33.4%) and Corporate Spend (3.4%).

In the US, 70% of education spend is skewed to the first 22 years of an individual's life.

The format and productivity of education provision have been largely unchanged over the past 100 years. In our view, a confluence of factors will transform who and what is taught, and how and where, as well as the productivity of education delivery in the coming years. The physical convening of students has been the biggest impediment to scaling education to date, but we believe that learning can migrate from a capital- and talent-intensive bricks & mortar business model into one fit for the digital era.

Evolution in the format and delivery of education over the next decade is likely to have significant implications for the allocation of global education spend, which we estimate at \$10.7 tn in 2018. In our view, corporates are well placed to benefit as global education spend shifts towards lifelong learning and technology-based solutions that can help improve the learning experience while reducing the capital intensity of delivering education to students. While the potential benefits to capital efficiency and student outcomes are significant, we recognise the meaningful barriers to transition, and that a shift would likely require higher initial spend in order to achieve more capital efficiency over the medium and long term. We believe that innovation will begin in areas with limited incumbency, and occur through a modular introduction of parts of 'The Future of Learning'. As these business models scale, we expect broader adoption across the learning spectrum.

We recognise that we are reaching a tipping point as the gap widens between skills delivered by the current system and those required by the digital economy. In our view, companies operating in career-long learning should see the most significant uplift to their addressable market (\$365 bn in 2018), while certain players serving the traditional student age population in developed markets that do not innovate will face headwinds. We expect technology players that reduce the capital intensity of learning (particularly post-primary, where supervision is less intensive) to gain share of spend over time, although staff costs will remain a dominant expense in global education.

Our outlook for 2030:

Who will learn? We expect the largest traditional early life 'learning populations' to be in Africa and Asia. Excluding Africa, the global traditional student population is set to peak in 2019, on our estimates. We also believe that the changing labour market will drive an increase in lifelong learning.

What will they learn? Education systems will likely become more skills orientated (vs. knowledge), prioritising the 4Cs (**C**reativity, **C**ollaboration, **C**ritical Thinking and **C**ommunication) beyond the 3Rs. We expect substantive growth in corporate learning spend and last-mile training to fill specific employee skills gaps.

How and where will they learn? Blended learning systems can use online learning to reduce the costs and capital intensity of delivering education. Digital learning offers the scope for personalised mastery learning at scale, driving better outcomes. We also believe that unbundling higher education into a modular credits system could improve student skills acquisition and better reflect the diversity of employer needs.

Exhibit 1: We expect global education spend to shift into several periods of reskilling over an individual's life, while technology will facilitate a lower capital intensity of delivering education at higher levels of personalisation

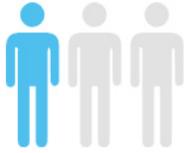


Source: Goldman Sachs Global Investment Research

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The Future of Learning in numbers



1/3 of the workforce is expected to transfer into new occupations over the next five years, according to BLS.



Global expenditure on education is equivalent to **10%** of the world's GDP, but it makes up less than 1% of the publicly listed equity market.



1 mn is the decrease in the number of university-aged students in the US in 2030 vs. 2015, on our estimates (5% of total student population).



70% is the reduction in the state cost of tuition achieved by Arizona State University through technology.



5x the global average is North America's per capita spend on education due to higher household spend.



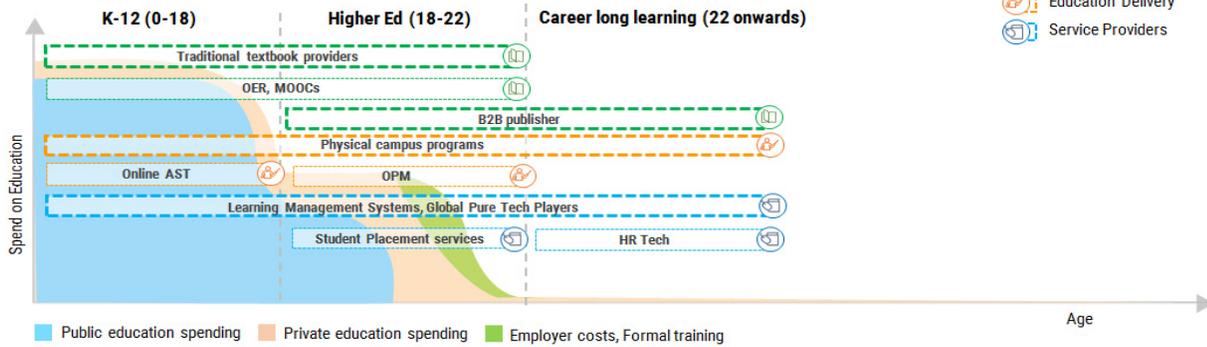
\$18.9 tn is the global expenditure on education that we estimate for 2030.



50%-70% of costs can be saved in an average corporation by shifting classroom-based training to e-learning, according to IOMA.

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LEARNING TODAY



DELIVERY

TAM tailwind

Tuition on Demand: Chegg*, iTutor Group, Photomath, DuoLingo, 3PL*, VIPKID, Rosetta Stone*

Study Resources and Student Network: Zybang, Brianly, Course Hero, K12*, BYJU, 3PL

Teacher Resources: Teacherspayteachers, TES Global

OPM: 2U*, Embanet* (owned by Pearson), Coursera, Noodle Partners, SEEK Education*

Last Mile Training: Staffing companies*, SoloLearn, Le Wagon, Ironhack, App Academy, Degreed, Strategic Education*

Online AST: TAL Education*, New Oriental Education*

Neutral

Professional: Kaplan, Pearson Professional*

K-12 Providers: OneSmart*, Bright Horizons Family Solution*, Sprix*

TAM headwind

Physical course AST or course providers: Kumon, Wall Street English, Career Education*

Physical College Providers: University of Phoenix, Grand Canyon Education*, Kroton*, Laureate*, Adtalem*



MATERIALS

TAM tailwind

Open Educational Resources/MOOCs: Lumen Learning, Khan Academy, edX, Coursera, Udemy

B2B Publishers: Wolters Kluwer*, Relx*, Informa*

Artificial Intelligence: LAIX*, Socratic, Knewton, Renaissance, Amira Learning

TAM headwind

Traditional textbook providers: Pearson*, HMHC*, Cengage, McGraw Hill, MacMillan, Lagardere*, China South Publishing & Media*



SERVICES

TAM tailwind

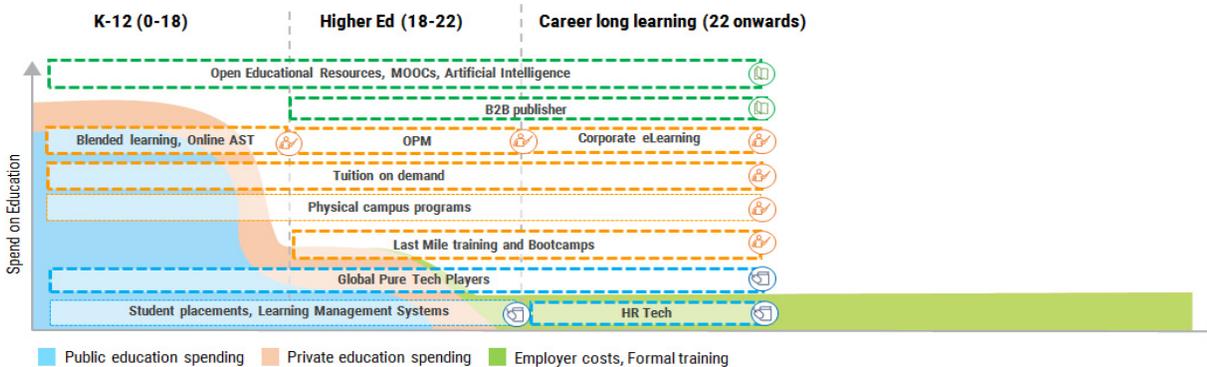
Technology Platforms: Microsoft*, Google*, Apple*, IBM*, Knewton, Sonic Foundry, Echo360, Instructure*, D2L, Blackboard

HR Technology Platforms: Cornerstone OnDemand*, Workday*, LTG*

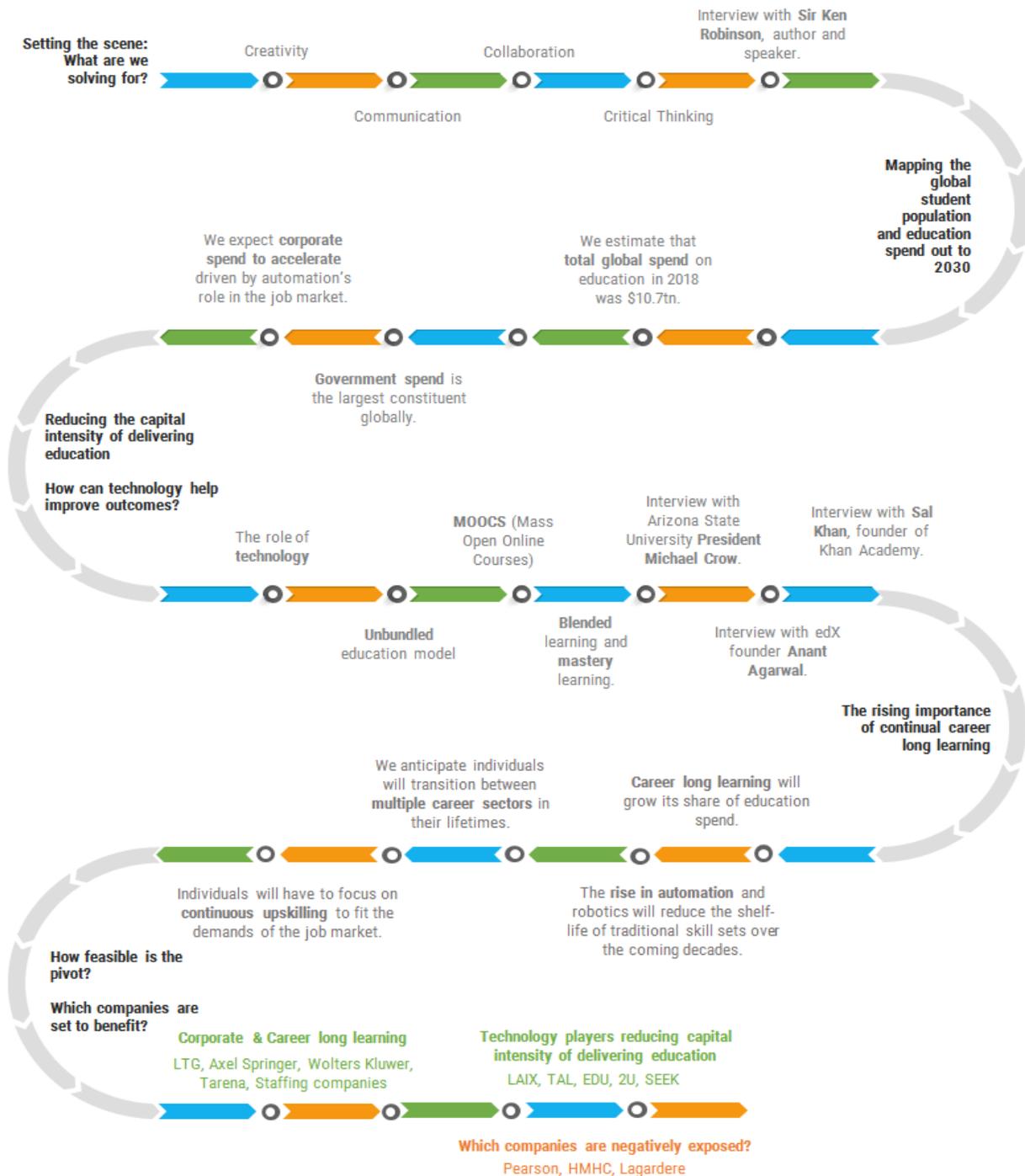
Student Placements: IDP*

*Publicly Listed Companies

THE FUTURE OF LEARNING



Roadmap through the chapters of this report



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For details on our global stock views across the education ecosystem, see our report 'The Future of Learning: Global stock recommendations', also published today.

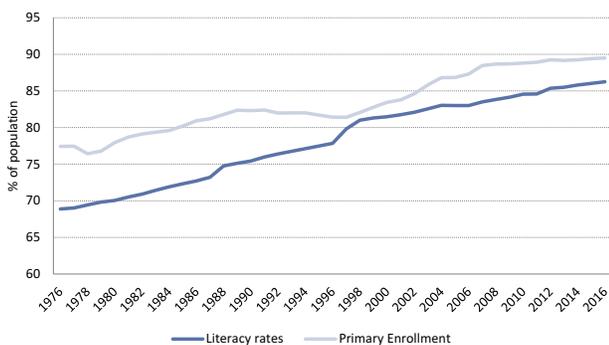
The authors would like to thank Brandon Cole, Amritpal Mann, Lisa Yang, Richard Manley, Katherine Alexakis and John Sawtell for their contribution to this report.

Setting the scene: What are we solving for?

We believe that the necessary skills for success in the digital era differ materially from those embedded in the design of the existing education system. As automation and technology transform the labour market, more emphasis is likely to be placed on developing skills that cannot be easily automated, such as creativity, collaboration, communication and critical thinking. We also believe that the pace of change will necessitate individuals retraining multiple times across their career, driving an increase in upskilling and career-long learning. Key beneficiaries of this shift include companies focused on developing soft skills, specific technical skills and lifelong learning.

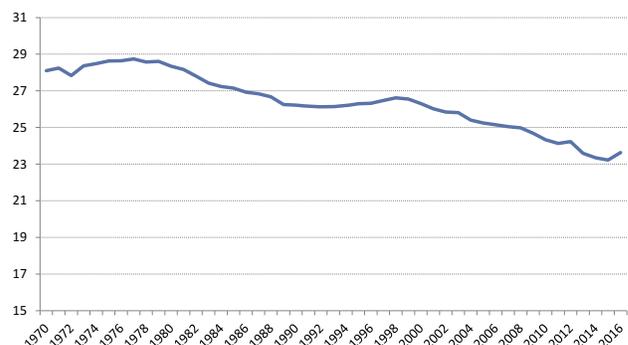
The purpose of education is multifaceted, ranging from societal contributions to productivity to equipping individuals to lead successful lives. The current education system prevalent globally was largely built on the needs of the industrial revolution, and while it has been hugely successful in raising literacy rates across the world, we believe the system needs to evolve to include an additional breadth of skills.

Exhibit 2: Global literacy rates and primary enrolment have improved significantly in recent decades...



Source: World Development Indicators

Exhibit 3: ...and student-teacher ratios have fallen
Global average number of students per teacher

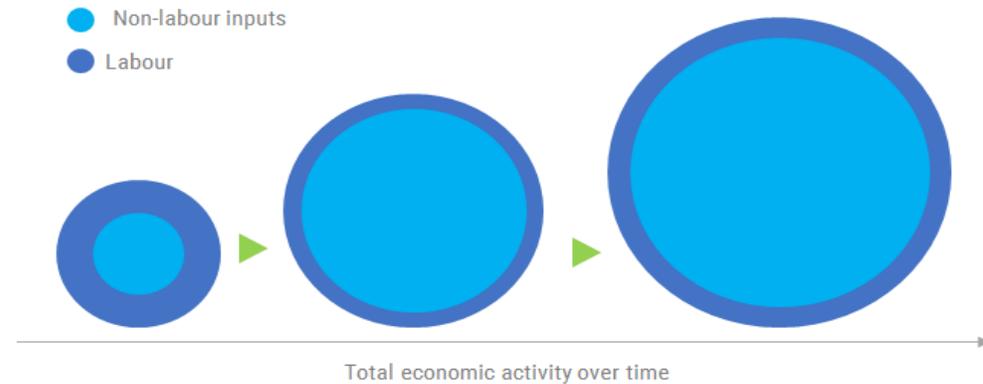


Source: World Development Indicators

The current educational system still largely reflects a paradigm in which young people specialise in a single trade or skillset, find lifetime employment in a single industry and then retire with a steady pension. While in 1900, only 17% of jobs required ‘knowledge workers’, today, the figure exceeds 60%¹. In our view, the evolving labour market is more likely to see people shift from one trade or skillset to another and from one industry to another, across the second or even third phases of their careers. The work of the future will therefore require an emphasis on a different set of skills: not just numeracy and literacy, but also adaptability, problem-solving, common sense and team-building, as well as the ability to adapt to rapid change.

¹ “Blended: Using Disruptive Innovation to Improve Schools” by Michael B. Horn & Heather Staker

Exhibit 4: The increase in 'non-labour' inputs in economic activity changes the role of the future workforce

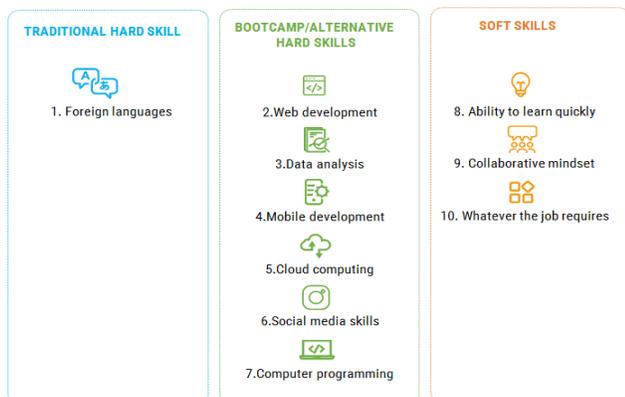


Source: Goldman Sachs Global Markets Institute

The skills necessary for success will also change as the permeation of robotics, automation and artificial intelligence transforms the jobs market. We believe the skills needed have moved beyond competence in the 3Rs (**R**eading, **wR**iting and **aR**ithmetic) and towards broader skills in the 4Cs (**C**reativity, **C**ommunication, **C**ollaboration and **C**ritical thinking), in order to fill roles that cannot be easily automated and many that have yet to exist.

The skills most sought after by employers in 2018 were skewed towards niche technology skills (web development/social media skills) and soft skills (ability to learn quickly/collaborative mindset). We expect the demand for technology skills to increase further out to 2030, with McKinsey forecasting an increase of 55% in the number of work hours spent on technology skills and 24% in those spent on social and emotional skills, versus a 15% decline in work hours spent on manual skills. Separately, the US Bureau of Labor Statistics' jobs forecasts suggest that the areas set for the most employment growth are in the healthcare, technology and food services industries.

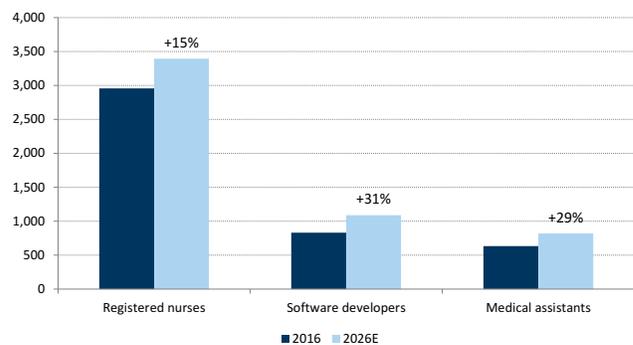
Exhibit 5: Top skills for getting a job in 2018 skewed towards niche technology skills and soft skills, which are not typically the focus of the existing education system...



Source: Glassdoor, Goldman Sachs Global Investment Research

Exhibit 6: ...while the occupations with most estimated job growth are in healthcare and technology

US Bureau of Labor Statistics Employment estimates 2016 vs. 2026E



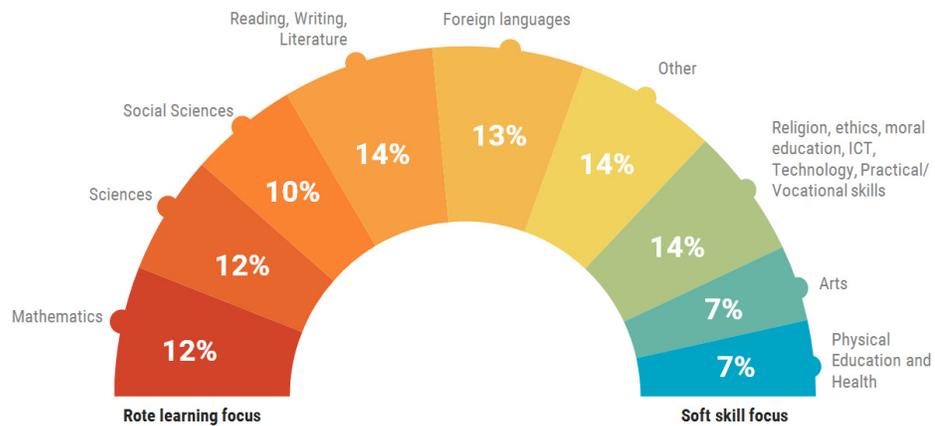
Source: BLS

“The world economy no longer pays you for what you know; Google knows everything...The world economy pays you for what you can do with what you know.”

Andreas Schleicher (Head of PISA, OECD²)

Despite these clear skills gaps, the existing school system spends a greater number of hours teaching subjects in which there is a focus on ‘rote-learning’, such as mathematics, science and languages (61%). While these ‘more academic’ subjects remain vitally important to a rounded education, we believe the changing world economy requires a shift to also include softer-skill focuses, not necessarily solely concentrated on the arts but integrated into all aspects of the curriculum.

Exhibit 7: The typical school day is currently skewed more towards ‘rote-learning’ subjects than soft skills
 OECD average school hours breakdown by subject



Source: OECD

We interview Sir Ken Robinson, whose TED Talk ‘Do schools kill creativity?’ remains one of the most watched talks in the TED archive. We discuss his views on the key skills individuals need in order to be successful in the future and the key barriers to change.

Note: The views stated in each of the following interviews do not necessarily reflect those of Goldman Sachs.

² Quoted in ‘Creative Schools’ by Ken Robinson.

Rethinking the key skills for the future with **Sir Ken Robinson**, Award winning speaker and author on creativity and innovation in education



Q. What in your view is the purpose of school and education more broadly?

A. There's a difference that I always draw attention to between learning, education and school. I think it's an important difference because, kids love to learn, they don't all get on with education and a lot of them have a bad time with school. The important distinction is that learning is a natural process. Young babies are voracious learners and we all are as we continue to learn things that interest us, we are deeply curious creatures. Education is a deliberate and intentional process of organized approach to learning. A school is a community of learners at its heart, and I think schools are very important because most of what we learn, we learn from each other and we learn with each other. It's why we all speak similar languages and have cultural values in common. We're highly social and collaborative creatures too and learning is a social and a cultural activity. The problem is that education has evolved into a great edifice and system of varied approaches, which have all kinds of political and corporate interests. Children get into school and go through with great gusto and appetite

for learning, but it starts to fade as they work their way through it.

The figures of disengagement and those people pulling out of education at the first opportunity are quite alarming. The reason I think is because schools have become certain types of institutions, built for efficiency and under all sorts of external pressures. So very often, schools are unable to create the conditions where children really want to learn. What I'm concerned about is how we can reconstitute schools so they cultivate learning rather than suppress it. As I see it, education has two big areas of responsibility. One of them is that we educate our children to enable them to identify and develop these natural capacities. But simultaneously with that, it has to help them understand the world around them so they can be part of it, contribute to it, understand the context in which they're developing and be active agents in their own lives.

Q. What are the key skills that you think young people need to learn today in order to be successful in the future? And how perhaps has this changed compared to previous decades?

A. I tend to think of education having four big roles. One of them is economic. We assume that when we invest in education there's going to be some economic pay off, that it will contribute to the growth of our economy, to their vitality and at the personal level, it will enable our kids to find productive work and work that may satisfy them and also help them to become financially active and independent.

When formal education became compulsory in most countries in the mid-to-late 19th century, the great driving force was industrialism, which is dependent on a very significant manual workforce and a much smaller professional workforce. With globalization and the impact of new technology, is the decline and fall of old industries, the rise of new forms of employment. I think that our systems have become preoccupied with academic work, with getting people to university with a certain type of analytical reasoning.

The result of it has been an absolute neglect and downgrading of all forms of vocational and practical training. I think competency is quite a good idea because it suggests, a nexus of understanding of concepts, of ideas, of knowledge and the practical skills. I've talked about them in my latest book, things like creativity, critical thinking, collaboration, citizenship and even composure.

Jeff Marano is estimating the loss of hundreds of millions of jobs as the AI revolution takes place. I mean, nobody knows for sure how that's going to play out, but what that does mean is we have to look very hard at these core competencies rather than keep on the old tracker thing that everybody gets a degree. I think all of these things are best met by understanding that we can't educate people in the way that we manufacture goods.

We have to help people to cultivate these core skills of creativity, critical thinking, collaboration and a compassionate citizenship because they're going to be vitally important for all of us as we move on. We're playing for very high stakes here and the idea that we can meet them by just getting more people to go to college and do degrees and get a higher GPA score seems to be a form of insanity.

Q. What do you see as the biggest barrier to change in the current education system? What is stopping us shifting to a system that is based on these competencies that you talk about?

A. There are several and one of them is political short-termism. Part of the issue here is that education is a very expensive investment on the parts of taxpayers and government, but the issues in education are very complicated institutionally. It's why I call creative schools transforming education from the ground up because I think that's where the real change is likely to happen.

The second thing is that the recent history of government engagement in education has been to try and raise standards by standardizing everything and becoming more controlling. A focus on more testing and more emphasis on linearity in the system. The way we fix education is by doing the exact opposite as some countries have done notably as you know in Finland.

So there are political obstacles in the way, there's the complexity of the system itself. There are also fixed mindsets about education. There are deep ideological views about how education should be conducted within the education community, that people will take very different views on these situations so it isn't that there's a consensus in the education world either. So it's a bit like the weather, these are complex systems and so there is a battle for attention and also a contest for the kind of guiding ideas of education.

However, if you look at areas of success of education, it's almost always areas where there has been an attempt at the political level to engage people who do the work to inform policy through practice. That's why Finland has been so successful, because they took their time to really consult with teachers, schools and parents and communities about the sort of education system they wanted for themselves and for their children.

Q. Focusing on those grassroots, how can the classroom cultivate some of these competencies you talked about like creativity, collaboration, critical thinking? Can you maybe speak to some examples about where this is happening well?

A. It's happening in all sorts of places, creativity isn't just about the arts, it isn't a single thing and it's not about one or other discipline. It's a way of creating new perspectives and bringing new things into being.

It's a way of getting kids to think differently about a problem that's happening. One example is the mind drive project in Kansas City where kids who were failing in school were engaged in a practical program to rebuild motorcars and to fuel them through social media. That was a fantastically successful project. Kids rise to the challenge if we give them a challenge that interests them and engages them.

When it comes to measuring creativity, creativity is not separate from critical thinking. It's not a theoretical idea. It's how we do things. It's how we get things done. And all the time, it's a kind of conversation between the idea, the problem and the materials that you're using. If you're creating a piece of sculpture from clay, then the way the process goes is affected by the materials you're using.

Years ago, I was involved in an initiative in Singapore. Singapore these days has become a very vibrant hub, but 25 years ago, it wasn't. The government there figured out pretty quickly that they had to do something to generate a new form of economic activity in Singapore and creativity was the way to do it. To attract new businesses, new investment, they have to understand what the conditions were that would draw people to such a place. Why are some companies highly innovative and others not? Why is it that some cities become celebrated because of the kind of vibrant, creative culture, why Paris in the 1920's, why London in the 1960's and why New York anytime and it's because of how things come together. What I'm saying is that you don't teach creativity in just the same as you teach somebody to learn to drive a car.

It's not just a matter of direct instruction, what the great innovative laboratories know is that you're getting people to become more creative not by abandoning their critical faculties, but by creating a culture in the organization where risk is encouraged. An environment where people are given permission to think differently, to explore new avenues of inquiry and to work together to beat their ideas around and to see what they can learn from each other. It's about creating a culture where creativity and experimentation is encouraged and facilitated.

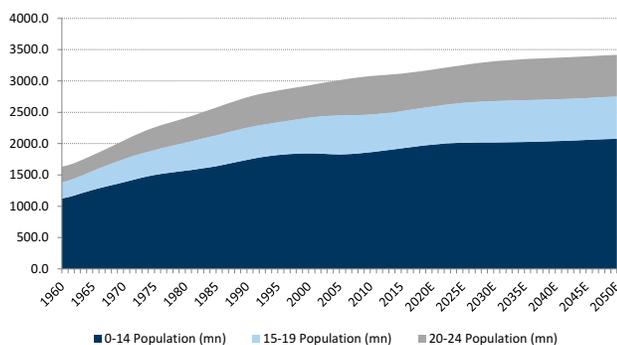
Mapping the global student population and education spend out to 2030

With traditional student age populations flat or declining in all regions outside the Middle East & Africa (+1.8% CAGR for 2018-30E), we forecast global education spend to slow slightly to a 4.9% CAGR in 2018-30 (vs. 5.2% in 2008-18). This is driven by a mix shift to lower-spend countries, slightly offset by higher spend in career-long and corporate learning. We see a disconnect emerging between areas experiencing pupil growth and the existing location of educational institutions. Key beneficiaries include companies exposed to positive demographic trends or career-long learning, as well as those that can help improve the efficiency of education delivery in countries with declining student populations.

In this chapter, we map out the demographic trends for the traditional student age population and our forecasts for global education spend out to 2030. We also reflect on current trends in the flow of international students.

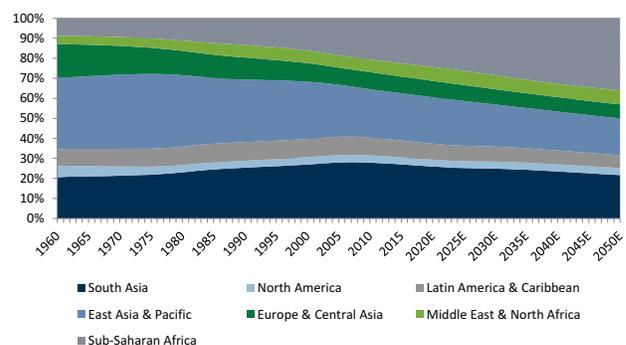
We use UN population forecasts to analyse the likely demographic shifts in the traditional student age population out to 2030. On the basis of these forecasts, the global traditional student population is set to grow at a 0.4% CAGR in 2018-30, consistent with the growth rate between 2000 and 2012. Within the mix, the traditional student age population is set to grow the fastest in the Middle East and Africa (+1.8%), decline in Latin America, Asia Pacific and Europe, and remain flat in North America (+0.2%). That said, we also acknowledge the risk to these forecasts from a fall in fertility rates in emerging markets (particularly MEA) to a level consistent with DMs, which could dramatically lower the demand for K-12 level schooling compared with our existing forecasts.

Exhibit 8: Global traditional student age population (0-24 years)
In mn



Source: World Development Indicators, Goldman Sachs Global Investment Research

Exhibit 9: The traditional student age population is skewing towards Africa



Source: World Development Indicators, Goldman Sachs Global Investment Research

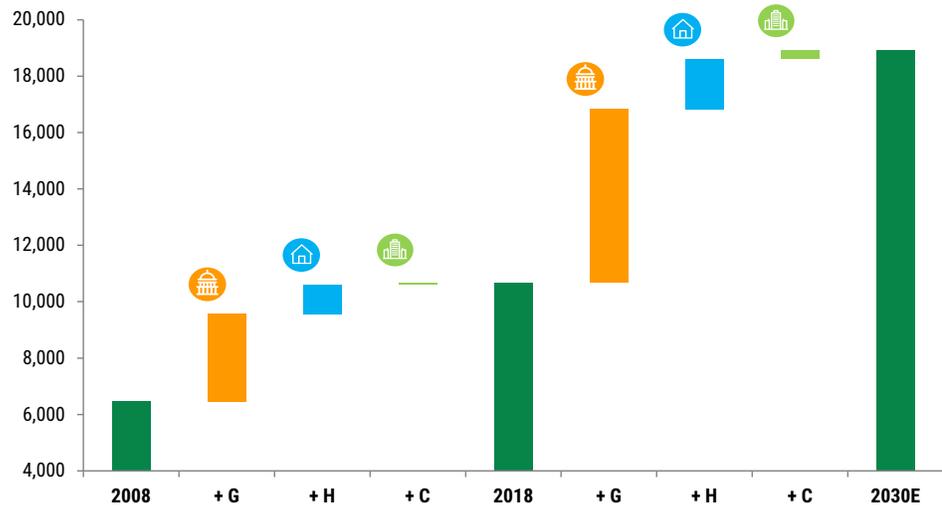
In our view, these changing demographics have implications for the installed base of capital, in that existing schools in certain regions are set to see lower student numbers, therefore increasing the capital intensity of delivering education in these geographies. Conversely, the rise in the student age population in countries that do not have a readily installed capital base for delivering education will also increase the costs involved in doing so.

We believe this may open the door to changing the delivery mechanisms in countries facing growing student populations while it also necessitates existing schools in areas of population decline to rethink their capital structure as they face negative operating leverage. For countries with growing student populations, a key question is whether they will replicate the structures from other countries, recycle the existing capital structure in place (potentially through higher levels of international students) or leapfrog into ‘the future of learning’.

By geography, spend on a relative basis since 2008 has increased the most in Asia Pacific, both by government and households. We forecast this trend will continue, with Asia Pacific reaching 35% of total global education spend in 2030 from 30% today, while we expect North America and EMEA to account for a lower share of spend (although still spending more in absolute terms).

We map out global education spend, with our model encapsulating: (1) government spend on education; (2) household spend on education; and (3) corporate learning spend. Overall, we estimate that total global spend on education was \$10.7 tn in 2018, and we forecast it will reach \$18.9 tn by 2030 – a CAGR of 4.9%, compared with a 5.2% CAGR in 2008-18E. We calculate spend per student or working age population (defined as the population under the age of 65) at \$1,540 globally in 2018, an increase of c.50% since 2008.

Exhibit 10: We forecast global education spend to increase at a CAGR of 4.9% between 2018 and 2030
\$ bn

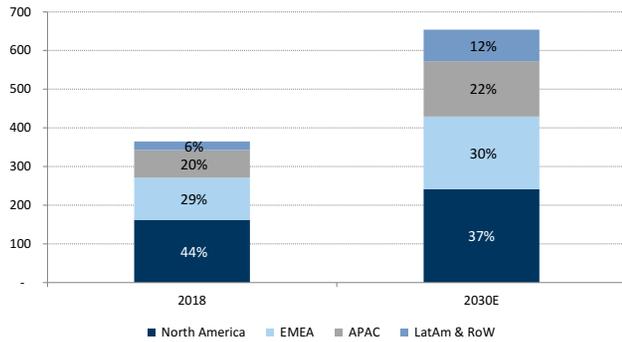


Source: Goldman Sachs Global Investment Research

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Exhibit 11: We forecast spend will shift more towards APAC by 2030

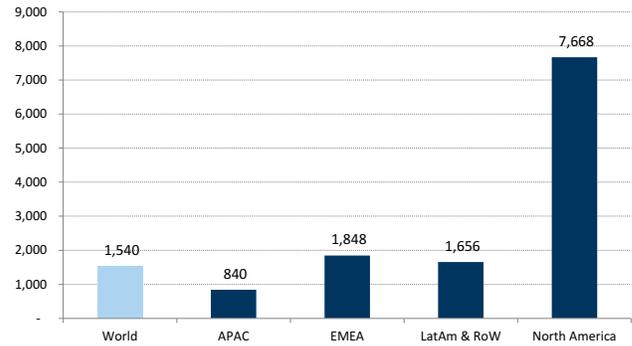
Total education spend 2018 vs. 2030E



Source: Goldman Sachs Global Investment Research, World Development Indicators

Exhibit 12: Overall spend on education per capita (0-64) is highest in North America

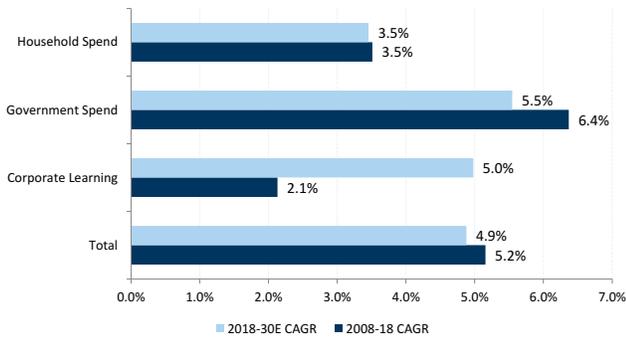
\$ total education spend/capita, 2018E



Source: Goldman Sachs Global Investment Research, World Development Indicators

Exhibit 13: Global growth rate in education spending across key parameters

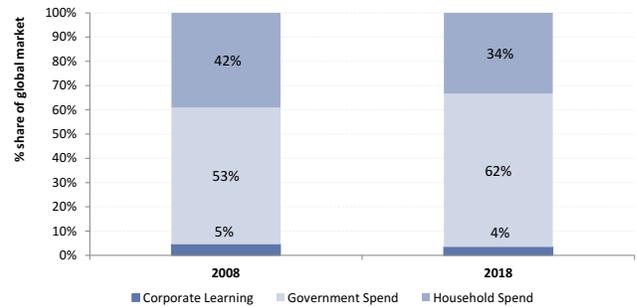
2010-18 and 2018-30E CAGR



Source: World Development Indicators

Exhibit 14: Government spend is the largest component of total educational spend and has increased

% of global spend

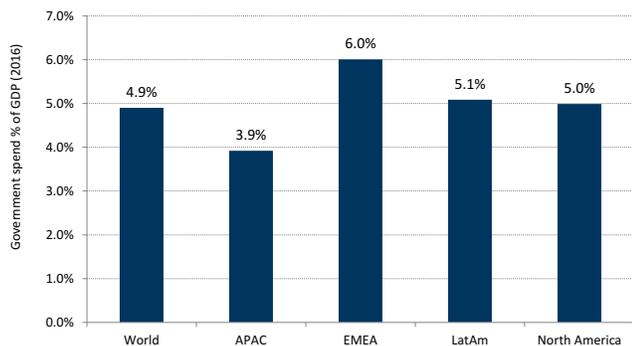


Source: Goldman Sachs Global Investment Research

Government spend is the largest constituent of education spend globally (c.60%) and grew at a 6.4% CAGR in 2008-18, driven by Asia Pacific, which grew at a 9.3% CAGR. Government spend as a percentage of GDP has ticked up gradually on a global basis, from 4.4% in 2008 to 4.9% in 2016. It remains highest in EMEA, at 6% of GDP, while APAC remains below average, at 3.9%.

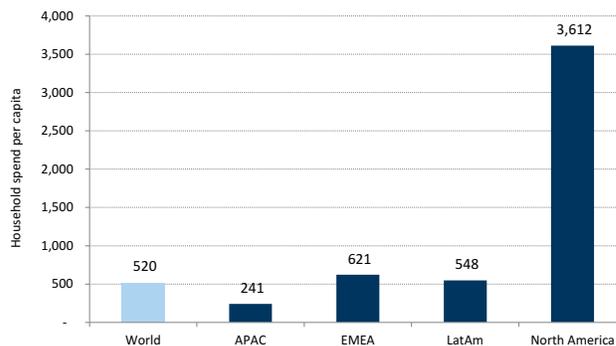
We forecast government spend to remain the largest contributor to overall education spend, an investment clearly predicated on improving the future productivity of the labour force. That said, we recognise the incentive for governments, particularly in the US and Western Europe, to improve the returns on investment given the current levels of public deficit. We believe that existing innovations in technology offer the opportunity to do this.

Exhibit 15: Government spend on education as % of GDP is highest in EMEA



Source: World Bank

Exhibit 16: Household spend on education is significantly higher in North America
US\$ per capita, 2018



Source: World Development Indicators

Household spend is the second-largest contributor to education and is likely under-represented in our model since it does not include extra-curricular activities such as music lessons, languages or sports, which could also be deemed educational and which take place outside the school environment. Household spend grew at a 3.5% CAGR in 2008-18, again driven by Asia Pacific, which grew at a 6.2% CAGR.

Corporate spend remains the lowest contributor to overall spend on education, at c.4% of the total in 2018, and grew below the total spend rate of 5.2% in 2008-18, at 2.1%. In our view, this was likely due in part to weaker corporate conditions following the 2008 financial crisis but also due to deflation in learning costs owing to the rise of e-learning. We also recognise that the trend of employers offering corporate funding for executive education has fallen, with 23.2% of EMBA students funded through corporate sponsorship in 2015 compared with 27.3% in 2011 (Executive MBA Council).

Our global education spend forecasts:

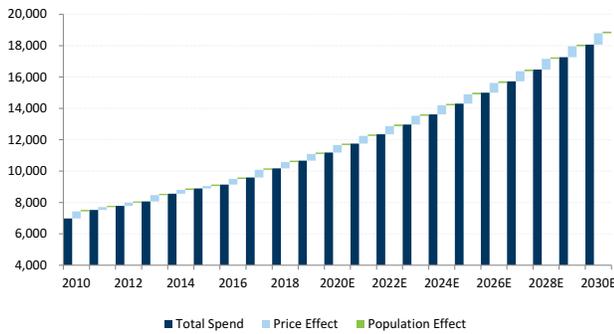
- We forecast global spend on education to grow at a CAGR of 4.9% between 2018 and 2030.
- We forecast government expenditure as a proportion of GDP to remain broadly constant, resulting in a CAGR of 5.5%.
- We expect household spend to increase by 3.5%, broadly in line with the prior period as an acceleration in LatAm & RoW offsets a slowdown in Europe & North America.
- However, we expect corporate spend to accelerate and increase at a CAGR of 5% in 2018-30E (2.1% in 2008-18E), driven by: (1) higher job churn due to the rise in automation; (2) the consequent increase in retraining; and (3) the need for new skills to be adopted widely into the employee base.
- We believe that much of the low-hanging fruit from the shift to e-learning in corporate spend is already complete, with 90% of companies saying they offer some type of online learning (LinkedIn Survey), suggesting price deflation will be less prevalent in our forecast period.

Our estimate of Global Education spend is made up of Government Spend (63.2%), Household Spend (33.4%) and Corporate Spend (3.4%).

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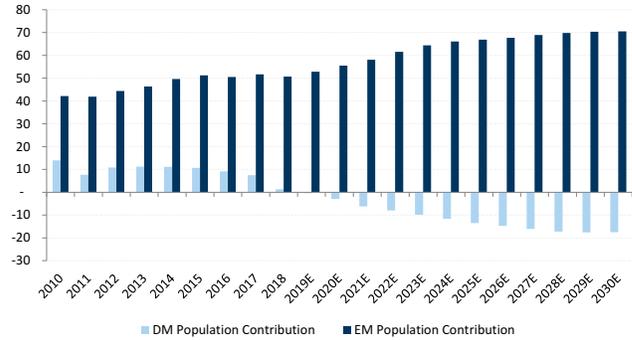
Historically, the overall spend on education has been driven disproportionately by higher spend per student than by population growth. Overall, population growth has been 0.4% per annum, which implies that overall spend per student has increased by more than 4% per annum from 2008 to 2018. We see this as partly a function of Baumol’s cost disease, which we discuss in the following chapter, and forecast a similar trend to persist into the future.

Exhibit 17: Education spend has been mostly driven by increased spend per student rather than population growth...
Global education spend, \$ bn



Source: Goldman Sachs Global Investment Research, UN Population data

Exhibit 18: ...with DMs a drag on the population component
Population contribution, holding per capita spend constant



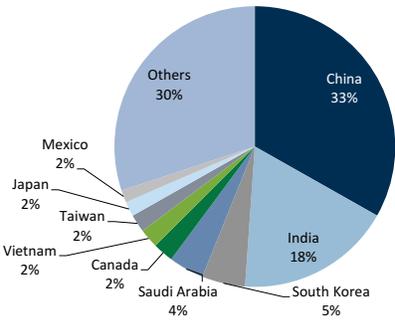
Source: Goldman Sachs Global Investment Research, UN Population data

International student trends

While domestic demographic trends are clearly one factor, we are cognisant that another key factor is the flow of international students, particularly at the higher education level. Nearly half of international students come from China and India, while the skew of international students by type of education is higher for master’s and doctoral courses. Across our global stock coverage, we highlight IPD Education as a player that provides international placement services in Australia, New Zealand, the USA, the UK, Ireland and Canada.

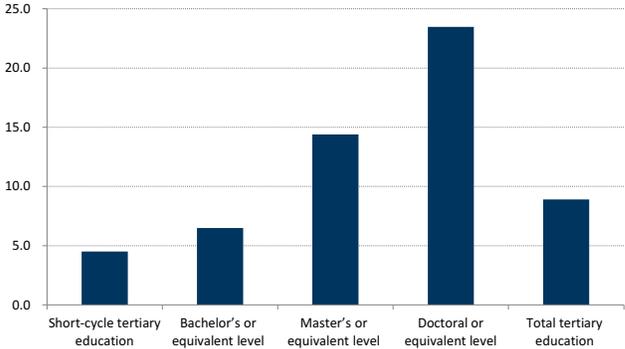
In the context of the changing demographic distribution of the future student population, we believe that international undergraduate and postgraduate student migration could remediate this tension, filling the excess capacity in countries with existing infrastructure and talent but declining student populations, currently set to drive negative operating leverage. We also see the opportunity for existing academic institutions in countries facing a domestic student decline to supplement their revenue through expansion into areas with growing student populations, with limited capital investment and largely through online learning. We note that this could also ameliorate the cost of investing in new infrastructure in regions with growing student populations.

Exhibit 19: International students by place of origin (OECD average)
2017/18, % of total international students



Source: OECD

Exhibit 20: International students tend to skew more towards master's and doctoral levels of education
OECD average, international students as % of all students enrolled 2017/18



Source: OECD

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Reducing the capital intensity of delivering education

The physical convening of students has been the biggest impediment to scaling education to date. We believe that through integrating technology and adopting various blended learning models, the capital intensity of delivering education can be lowered substantially, by 20%-30%. We also believe that the unbundling of higher education into a modular credits system would serve to improve the efficiency of students achieving the specific skills they require in a more flexible way. Key beneficiaries include online content and delivery providers.

In this chapter, we discuss a variety of Blended Learning models, online higher education and the potential from unbundling the higher education accreditation system.

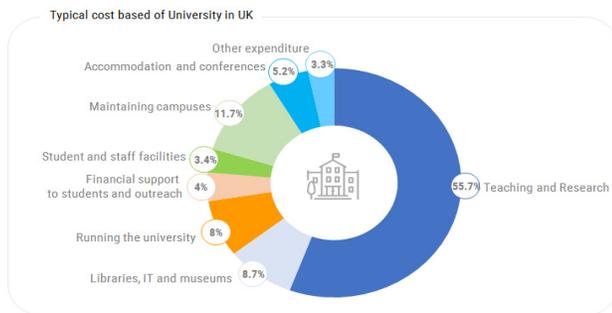
The key costs involved in delivering education in the traditional format have been staff costs (c.75% for K-12 stage), building/maintenance and then educational materials. While we believe that the human element of teaching is essential and will remain pivotal to the delivery of education in the future, we see an opportunity for technology to improve the efficiency with which teachers are able to operate.

Global spend on education has increased at a 5.2% CAGR over the past 10 years, with spend per student increasing 4.1%, on our estimates. The inexorable rise in the cost of education has been blamed by some on Baumol's cost disease, linking the increased cost to higher wages without productivity gains, in response to rising salaries in other jobs that have experienced higher labour productivity growth and hence a supply and demand imbalance.

As we question what the education system looks like in a digital era, we begin by unpacking how technology can change the cost base. The clearest manifestation of this is the use of online learning to eliminate real estate costs (c.20% of the existing cost base of a typical UK university). The lack of physical constraints on the number of students convening also enables the remaining cost base to be spread over a much larger number base, which should further reduce costs.

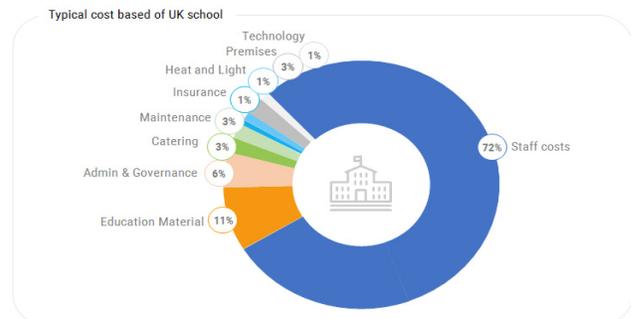
Beyond this, we see scope for technology to reduce expenditure on libraries and IT as students increasingly use their own devices, reducing the need for campuses to supply such an extensive hardware base. We also view the opportunity for Open Educational Resources to take share from traditional educational materials as a significant potential cost saver for both schools and universities.

Exhibit 21: Typical cost base of university in the UK



Source: HESA

Exhibit 22: Typical cost base of a UK school



Source: Duntop Academies

The challenges to reducing the capital intensity of education vary at each stage of the education system. In the early school years, it is unlikely that capital intensity falls at all given the necessary supervision levels (however, this also enables parents to remain productive in the workforce); we believe this section of education is likely to remain subject to Baumol's cost disease on an ongoing basis. In the later years of school, when more individual study is involved, we see the opportunity for forms of blended learning to improve the flexibility of administering education and allow teachers greater reach.

At the college level and beyond, we question the long-term sustainability of rigid degree structures and highlight the potential for the unbundling of the accreditation system to allow students to build their education in a modular fashion.

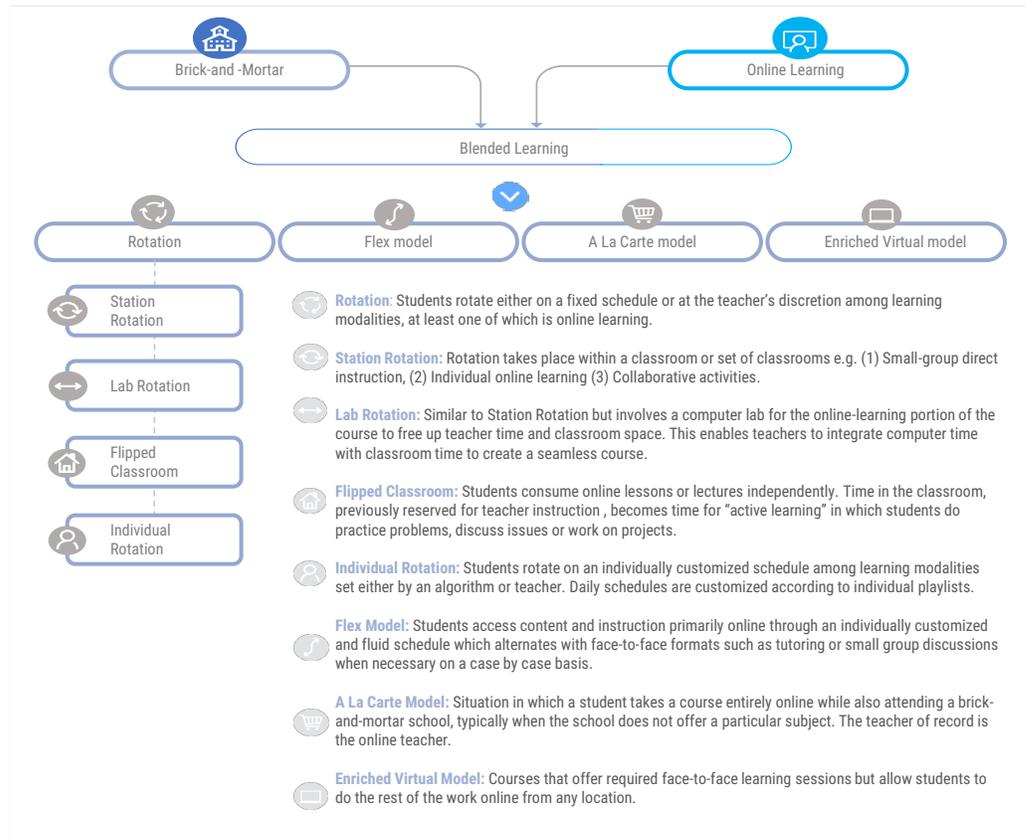
As we discuss with President Crow and Professor Anant Agarwal further on, the opportunity for students to collect credits from a wide range of institutions, both online and on campus, on a completely time-flexible basis paves the way to significant disruption in the existing tertiary education system and the cost base that supports it.

Blended learning offers a compelling solution

In our view, a shift to blended learning presents the most compelling opportunity for improving affordability, flexibility and outcomes. It offers scope to reduce the capital intensity of delivering education, while ensuring that the human and community elements of teaching are best utilised.

Blended learning involves leveraging the internet to afford each student a more personalised learning experience, including increased student control over the time, place, path, and/or pace of learning.

Exhibit 23: Blended learning involves both brick-and-mortar and online learning and can take several different forms



Source: Christensen Institute, Goldman Sachs Global Investment Research

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We illustrate several models of blended learning below, including various rotation models, which involve students alternating between online instruction, teacher-led and collaborative peer-to-peer activities, as well as flex models that operate a central study/collaboration space with more specific interventions on the periphery in which students can participate.

Carpe Diem schools in Arizona save 16% on a per child basis by switching to an individual rotation blended model.

Adopting a ‘lab rotation’ model has saved Rocketship schools \$500k per year. They are able to pay their teachers 10%-30% more, extend the school day, provide leadership training and employ more staff.

The notion of ‘flipped learning’, which we discuss in more detail further on with Sal Khan, founder of Khan Academy, enables students to consume material individually, at their own pace, and then spend classroom and teacher time on problem-solving or project-based work. We also see methods such as individual rotation/flex model as innovative ways of enabling teachers to focus time on smaller groups of students. In China, offerings such as TAL’s Xueersi.com illustrate a dual-teacher large group model. This involves students enrolling into a live broadcast with a teacher, which simultaneously allows a live discussion and interaction managed by a designated tutor. We see the examples from schools that have adopted blended learning approaches as an encouraging sign that costs can be saved or reinvested to better support existing teachers.

Exhibit 24: The ‘station rotation’ blended model involves students rotating between online instruction, teacher-led instruction and collaborative peer to peer activities



Source: Christensen Institute, Goldman Sachs Global Investment Research

Exhibit 25: The ‘individual rotation’ model involves an online focused central learning lab supplemented by direct instruction and interventions in smaller groups



Source: Christensen Institute, Goldman Sachs Global Investment Research

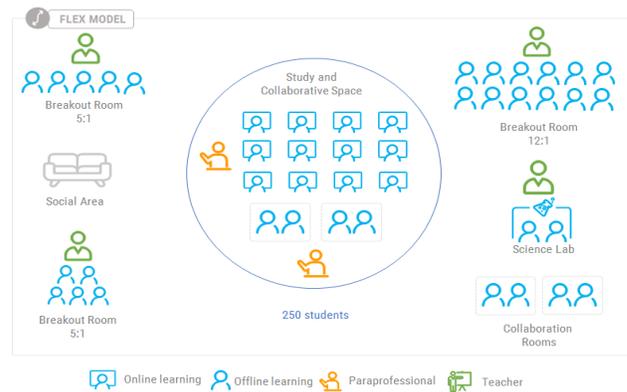
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Exhibit 26: The 'flipped classroom' model involves students receiving instructional content through videos they watch at home and then putting that knowledge into practice in the classroom



Source: Christensen Institute, Goldman Sachs Global Investment Research

Exhibit 27: The 'flex model' involves a central study and collaboration space supplemented by breakout rooms to accommodate smaller group sessions

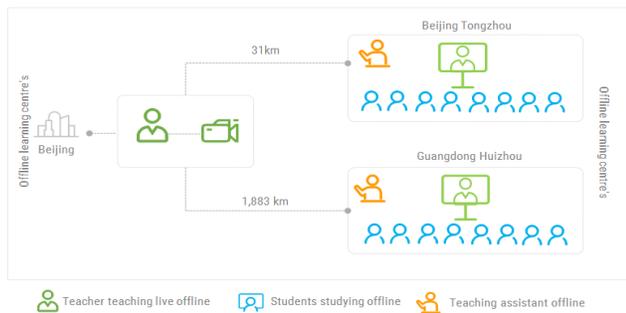


Source: Christensen Institute, Goldman Sachs Global Investment Research

In China, New Oriental and TAL have been piloting the offline dual-teacher model since 2015/2016, a model that was tested and proven by Tarena (TEDU) in the area of adult professional IT training since 2006. The offline dual-teacher model is relatively mature, in our view, which has helped EDU/TAL reach into areas beyond top-tier cities, or distant areas in top-tier cities while delivering lower teacher costs, improved student engagement, and lower capital intensity.

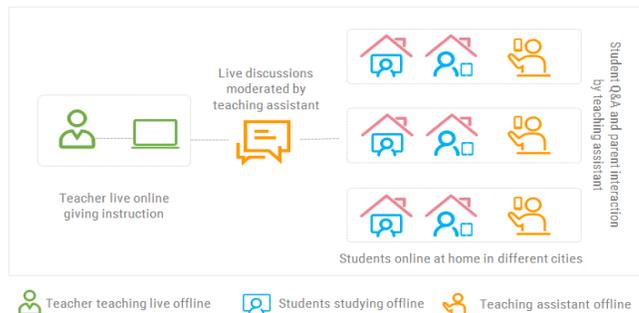
As China's education companies including the AST players invest more into online tutoring, a new version of the dual-teacher model has evolved in the online space. In a large dual-teacher live broadcasting class, the teacher sits in front of a computer while students watch live tutoring and participate in the live discussion panel. A teaching assistant or online tutor is assigned to every group of c.50 students, responsible for duties such as managing the discussion panel. This online dual-teacher model further addresses the capital intensity issue, and improves the convenience and affordability of delivering education.

Exhibit 28: The offline dual-teacher model involves students from multiple locations convening to watch a teaching broadcast



Source: Goldman Sachs Global Investment Research

Exhibit 29: The online dual-teacher model supplements the teacher broadcast with live discussions moderated by a teaching assistant available from students' individual homes



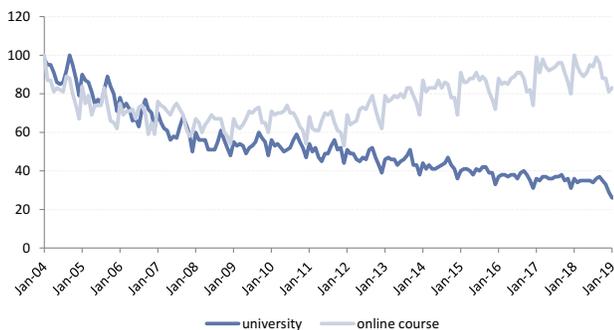
Source: Goldman Sachs Global Investment Research

Online higher education

As universities have grappled with declining enrolments, many have embraced revenue streams from off-campus students through offering fully online degrees. In many ways, this is not a new idea, with the Open University in the UK has been offering 'distance learning' degrees since 1969. Similarly, Chicago Booth Business School has opened locations in London and Hong Kong that operate as a remote convening centres with seconded faculty and live-streamed lectures. However, technology and the emergence of key 'Online Program Management' service providers such as 2U, Embanet (acquired by Pearson in 2012) and SEEK Education have made this an easier avenue for institutions to pursue.

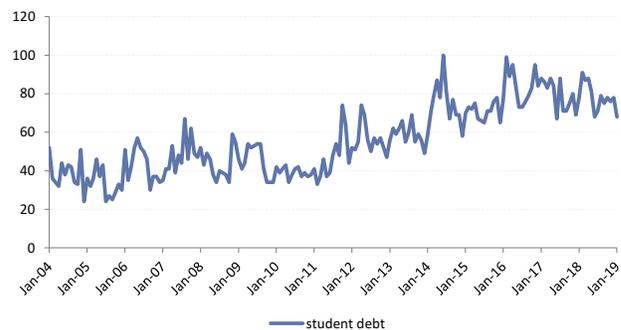
While we see this as an attractive market with a significant runway of growth ahead, we are also cautious that increasing competition (recent entry of Coursera and Noodle Partners) and higher student acquisition costs may affect the longer-term margins of the business model, particularly for shorter courses, which may require significant marketing for lower fees per student. We note that pure play 2U spends 55%-60% of revenue on sales and marketing costs. That said, we believe concerns around student debt, which can be limited through the flexibility offered by online degree courses, will continue to drive increasing student numbers.

Exhibit 30: Searches for the term 'university' have fallen, while searches for 'online course' have risen
Google Search Trends (Index 100 = Jan 04)



Source: Google Trends, Goldman Sachs Global Investment Research

Exhibit 31: Searches around student debt remain high
Google Trends data



Source: Google Trends, Goldman Sachs Global Investment Research

Company spotlight: 2U; TWOU (covered by George Tong)

2U is an education technology company that partners with top colleges & universities to bring their degree programs and credit-bearing courses online. The company also recently acquired 'GetSmarter', a platform that offers accredited short courses on behalf of leading universities such as Harvard, University of Oxford and MIT.

Unbundling higher education

The unbundling of the tertiary education system could open the door to significant changes in the way that education is delivered and qualifications are awarded. In our view, a shift to a modular credit system, whereby students can earn individual credits from a range of institutions both online and on campus – building a portfolio of certificates which, over time, can build to a full degree but are also valuable in their own right – represents a key opportunity to reduce the capital intensity of delivering education.

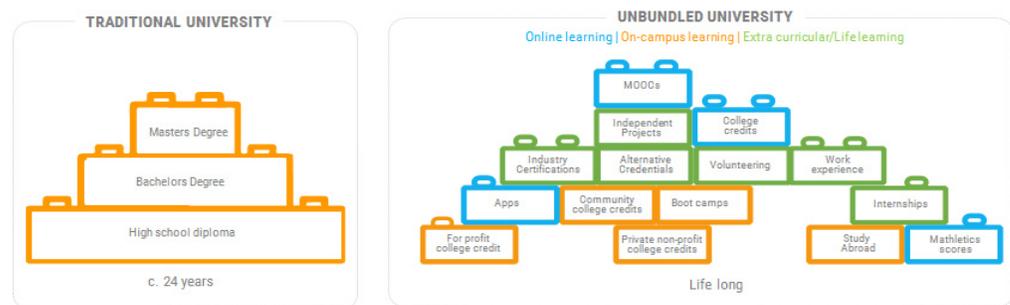
edX’s “MicroMasters” programmes typically cover 25% of a full masters degree which can be completed fully online and are accredited by top institutions including MIT, Columbia and Berkley.

In many ways, this would represent the way the workplace recognises experience later on in a person’s career, assessing different areas of experience based on prior employment. The structure of the US college system remains binary for students, with the outcomes being either graduating and achieving the full recognition of studies or dropping out and achieving no recognition while still bearing the cost of attending.

In contrast to the status quo of largely identical university faculty offerings, we believe that unbundling would enable colleges to pursue the areas in which they are naturally strong or unique. In our view, specialisation would drive economies of scale, lowering costs, as well as enabling a higher quality of course delivery.

As we illustrate below, this could mean an individual can build a mosaic of qualifications, which would have clear implications for the way universities are structured, but also the types of materials used. We continue to see universities as critical parts of the education system, but believe that they also face a need to evolve with the needs of students and the benefits of technology.

Exhibit 32: The potential opportunity from unbundling higher education



Source: Goldman Sachs Global Investment Research

We believe that the unbundling of qualifications could drive a shift towards reinvigorating community colleges/vocational training institutions and improving graduation rates (c.40% of students in the US who enrol in a four-year undergraduate degree do not graduate within six years (NCES)). Chicago offers an interesting example of partnering with employers, enabling high school students to enrol to obtain vocational credits and a fully funded scholarship for students that achieve a specific grade-point average. The state’s high school graduation rate has increased from 56% in 2011 to 78% in 2018, largely attributed to the dual-enrolment system enabling students to pick up vocational credits.

We interview President Michael Crow, who is leading the way in innovating US Higher Education at Arizona State University through the use of technology to improve affordability and outcomes. We then speak with Professor Anant Agarwal, the founder of the world's largest Mass Open Online Courses (MOOCs) platform, which offers modular courses from leading universities such as Harvard and MIT.

Innovating US Higher Education with Michael Crow, President of Arizona State University



Q. In your view, what are the key underlying problems facing US higher ed institutions today?

A. The principal problem is that US Higher Ed Institutions have been inadequate at adapting to the social changes in the United States and in doing so have proven that they are overly rigid.

Q. What was the inspiration behind launching the "New American University" model and what does it seek to achieve?

A. The US was founded as the first major emergent self-determined democracy and what we are looking to do is to create a highly egalitarian institution for all talented people regardless of their background or their family income. Not as a mass education institution but a discovery oriented research institution, a new kind of American Research University deeply dedicated to accessibility while also being unbelievably creative.

Q. The notion of accessibility, affordability clearly continues to be a significant issue within the US higher Ed landscape. Can you talk about some of the measures ASU has taken to address this?

A. Well several. Number one is to basically say that we will find a pathway for every student from every family, regardless of their family income and we will do that at scale. We have 12,000 undergraduate students who are qualified to attend the university who come from families with no strong income or are on government support, which is a large number. Secondly, and perhaps more importantly is to use every advantage that technology can give us in terms of enhancing learning outcomes, the speed and quality of learning measured, while also containing costs. Right now we have a cost that can't be contained that is accelerating at 3-5% per year infinitely into the future. American private colleges and universities are now charging \$50,000+ tuition with a \$70,000 annual cost to attend which is continuing to accelerate so even for wealthy families, we are getting into the realm where it is unattainable. So from our perspective, we need a completely new approach. We decided to embrace technology from more than 200 separate technology developers and match that with our own technology capability in those areas where we needed better learning outcomes at lower cost, and we have been able to achieve that.

We keep hearing about the notion of "debt crisis" which is portrayed in the media by finding highly exaggerated cases of massive amounts of debt taken by individuals who are now not employed. However there is no debt crisis relative to the financing of debt from government. The "debt crisis" is what we call a "completion crisis". If you graduate with some debt and have some degree or certificate and look only at the educational expense and living expense while you are in school, debt is very manageable. If you don't graduate, which is sadly the case for more than half of the people who start their college in US, then it is a problem. So one of the things we have done and one of the things that we think others should do is to work on how to help people to complete. Our 40,000 online degree seeking students are almost all individuals who started college and didn't finish due to life circumstances. The Starbucks program that we put in place a few years ago has produced 3,000 graduates with no cost and no debt and we are going to be producing 25,000 graduates from that program. Over half of Starbucks' employees in US went to college and didn't finish and are paying debt on what they didn't finish. We are helping them to finish.

Q. Can you talk about specific aspects of technology that are helping you to achieve that, and particularly I suppose, in terms of bridging that gap between enrolment and completion?

A. We have adaptive learning technologies that allow us to teach across the entire spectrum of learners. We have big data analytics technologies that allow us to apply our resources where they are most needed. We have tutoring technologies, academic advising technologies, gaming technologies that allow you to simulate your pathways through the universities in terms of majors and moving through the majors. We have technologies that allow us to analyse your writing and have the equivalent of 100,000 readers look at your work in addition to your tutor or professor. These are all augmentations that are happening; none are replacements. We have this applied in digital engineering classes, digital science laboratories, digital photography classes and it makes these classes better than analog. In a digital photography class for instance, the ability of your work to be reviewed and analyzed, altered and instructed by 50 other people who are looking at what you are doing creates a much better environment that is really powerful.

Another example is some of the students in our music school were admitted to Julliard, an elite music school in New York. However they didn't go to Julliard as students there cannot also be an engineering major. Here you can be an opera major or an engineering major because we have technological tools that allow you to move on both dimensions at the same time.

Q. ASU recently won the number 1 rank in the innovation segment from US News for the fourth consecutive year. Can you talk about what that means and how it is determined and what do you think attracted the jury's attention to ASU specifically?

A. It's determined by 1500 voters and 500 or more national colleges and universities with the voters being asked who think is the most innovative. We won it because people see that we are able to make those fundamental differences. We have students from every family background imaginable and are amongst only 4 universities in US that have a Rhodes, Marshall, Churchill and Truman scholar. Our graduates are doing fantastically well and people ask "how are you doing that when you are taking such a broad cross section of graduates and given how large you are?" and we say it's the technology is really enabling us to do these things and the innovative things are coming out of that. For example, we have gone from 8,000 engineering students to 18,000 and we have added 4,000-5,000 women in engineering from before and greatly enhanced the retention rate in engineering from less than 70% to c. 90% which is all a function of culture change, pedagogical change and technology. Our engineers are recruited at unbelievable salaries and returns with ASU being in the top 5 providers of talent to Intel, Boeing, Apple and other major Silicon Valley companies. We are producing a fantastic product in large number with high diversity at a lower cost which the technology allows us to do labelling us as innovative. We have reduced the cost to the state to produce a single degree by c. 75%.

Q. On that point of cost, what do you think is the main driver of the above inflation level of cost growth? Linked to that, could you also point out which are key areas of higher education that are scalable and areas that aren't scalable through technology or other means?

A. One of the things that we think will happen is that certain universities like ourselves and Purdue University will become scalable entities that are driven by an intensive research scholarship core. We don't think every university should do that but some universities have to do that or need to do that for the benefit of society, so what we are seeing is the emergence of a new class of universities and ASU/Purdue are some examples of that. The limits to all of this is that it works in some places and in some places it doesn't as it's not meant to be a replacement model but an augmentation model.

To your question on cost, there is where we have the major problem. What you see in Baumol's law is that cost of labour rises infinitely because there is no way to value that labour due to lack of replacement. We are not operating in a labour replacement mode but what you want to look at is that costs rise infinitely in higher education unless you can constrain the demand. So unless you inject technology in some way, you cannot change the outcomes on a cost perspective in a positive way.

Q. How can the degree programs and credit systems be made more flexible?

A. They can be made more flexible by not replacing what we have but by augmenting what we have. We need tradable and stackable credentials that can be understood and we need more micro-masters degrees and we need different ways to move three micro-masters towards a main degree or something to that effect.

Q. If you could make the US college system from scratch, what would it look like?

A. It would be less evaluation based on selectively and more evaluation based on outcomes and it would be driven towards higher and higher levels of differentiation.

Unbundling Higher Education and the future of MOOCs with Anant Agarwal, CEO of edX



Q. Can you start by sharing with us who is the typical student on edX and what are their main motivations for participating in an edX programme?

A. Broadly speaking, we have 20 million students on edX ranging in ages from 4 and a half years to 97 years, from every single country in the world. However, the median age of the learner on edX is around 26 years of age, and so the typical learner is one that is in college or is looking for a job or has begun work and is looking to upskill themselves in order to advance their career.

Q. You've talked about the power of MOOCs to democratize education. Can you walk us through what this means in practice?

A. The traditional form of education is one where a small number of students comes to campus in order to learn. A quality education has either been the privilege of people who are very bright or people that are very rich or people with very good connections. For the average learner, for the masses, a quality education is still inaccessible. We believe that applying digital technology can democratize education. In the past 7 years, MOOCs have come to the forefront in enabling learners all over the world to learn at scale where they can be anywhere, they can be anyone with a will to learn and an internet connection.

Q. MOOCs have added to the flexibility of education, can you talk us through the MicroMasters® that are being offered through edX and the place that you see for them in the evolving education landscape?

A. Absolutely. Our previous education system or the traditional education system is a one-size-fits-all. Now we believe that education needs to be flexible and needs to satisfy the varying needs of students. Does everybody need four or six years of education? To study in a single discipline? To be in one place at the same time in order to learn? To learn at the same pace? The answer is a categorical no.

I think we need to create a lot more flexibility in our education system where people should be able to learn anywhere, any quantity, whatever they want at any time at very low cost. Take Master's degrees, usually you go to a campus and you spend two years on a Master's degree in the US for \$40,000, \$50,000, \$60,000.

People need to upskill and reskill but the odds that they're going to be able to go to a campus for two years are virtually zero. MicroMasters programmes are a radical new approach to solving this problem. It's called modular education. Instead of a full Master's degree maybe you just need 25% of a Master's degree and so a MicroMasters is typically about 25% of a Master's degree, which you can get completely online. When complete, you get a high valued credential from some of the top universities in the world like MIT or Columbia or Berkeley.

This creates a form of education that you can liken to the Lego model of education where you can earn these MicroMasters programmes, and like Legos, you can combine them in various ways. You can earn Legos from multiple universities. You can stack them to get full Master's degrees. So for example on edX, we just launched a stacked Master's degree from ASU where you earn a MicroMasters programme certificate in supply chain management from MIT and then you complete the coursework online on edX from ASU and you earn the full Master's from ASU.

Q. I suppose what you're really getting at there is this concept of unbundling, and if we think about how other platform models across the economy have disrupted incumbent systems, unbundling has been a key aspect of that. In your view, what could this look like in education?

A. Unbundling is what enables us to create a modular form of education. A learner will be able to earn these micro-credentials and they might spend two years studying online earning micro-credentials and getting a job, and later on if they decide to go to campus for a year, then decide to go to the job market, and they earn more credentials. At some point, they decide they have enough for a degree, but these credentials will stack whether you do them online or on campus.

Today we have admissions because there is no room on campus to allow everybody that wants to come in to come in, but with these modular stacked credentials like the MicroMasters programmes, it's open admissions, everybody's welcome. You essentially have the admissions test at the end so that only competent students will pass, but no one is prevented from coming in. I envision a new form of education, and universities will be a big part of it but they will need to transform themselves to be a part of this modular education.

Q. MOOCs give rise to the opportunity for universities themselves to in some ways become content providers with the potential for them to license those courses as a next-generation type textbook. Are we seeing any evidence of this so far?

A. Absolutely. We are seeing many examples where once you make education modular, you can build a sharing economy. If I am teaching a course at MIT, I have routinely used textbooks from another colleague at another university, not everything has to come from me.

When we unbundle education into modules, more universities can share, and so an online course on edX or MOOC can become the New Age textbook, and we are working with many community colleges where this is happening. We are working with the IT University in Pakistan, and they offer a Data Science Master's degree where students take the first six courses on campus in computer science, and then they use the Data Science MicroMasters programmes on edX that comes from University of California, San Diego. They use that as a New Age textbook, and the students learn completely online on edX and they do the four courses from UCSC on edX and Data Science, but they get the Data Science degree from their campus.

Universities can use some pieces from their own campus that they're excited about or good at, and then they can borrow pieces where they don't have faculty or where they want to get a different perspective. That can come from outside from platforms such as edX, and we're doing that with community colleges where they're using our content. We're doing that with colleges around the world, and I think that will be a very important model going ahead.

Q. It's clear that flexibility is just so core to this and I know that you've made the edX platform Open edX, open-source, enabling organizations to launch their own learning platforms and things like that. Can you talk about the decision you took here and the impact that you are seeing from doing that so far?

A. We made Open edX available so that anybody could download it and launch their own platform for free. We made that decision early on because we believed that it would open up a new level of access to education, reaching people that we may not be able to reach ourselves, and we've been pleasantly surprised by the uptake. There are 1,800 Open edX sites today around the world in the five years that edX has been open-source with 25 million additional learners on these sites. So in all we've reached 45 million learners all over the world making this the world's largest MOOC platform. Of those 1,800 sites, many of them are entire nations such as Israel, Russia, France and many others.

How can technology help improve affordability, flexibility and outcomes?

Beyond the cost equation, we also believe that technology can be used to scale the mass personalisation of education and improve outcomes through mastery learning, which requires students to move at their own pace to master 90%+ of material before allowing them to move on. We also see scope for artificial intelligence to further disrupt the space through its deep analysis of user behaviours, enabling it to deliver a personalised learning experience. Key beneficiaries include technology players offering superior services driven by the use of data analytics or other engaging technology such as ‘gamification’ to improve learning outcomes.

In this chapter, we discuss fully personalised mastery learning solutions, prominent EdTech offerings, gamification of learning and artificial intelligence.

While technology through blended learning can help improve the flexibility of delivering education, we recognise that it is also important to explore how it affects student outcomes. It is widely recognised that 1x1 fully personalised tuition produces the highest levels of academic achievement, as tutors are able to dynamically observe and intervene where knowledge gaps occur and remediate.

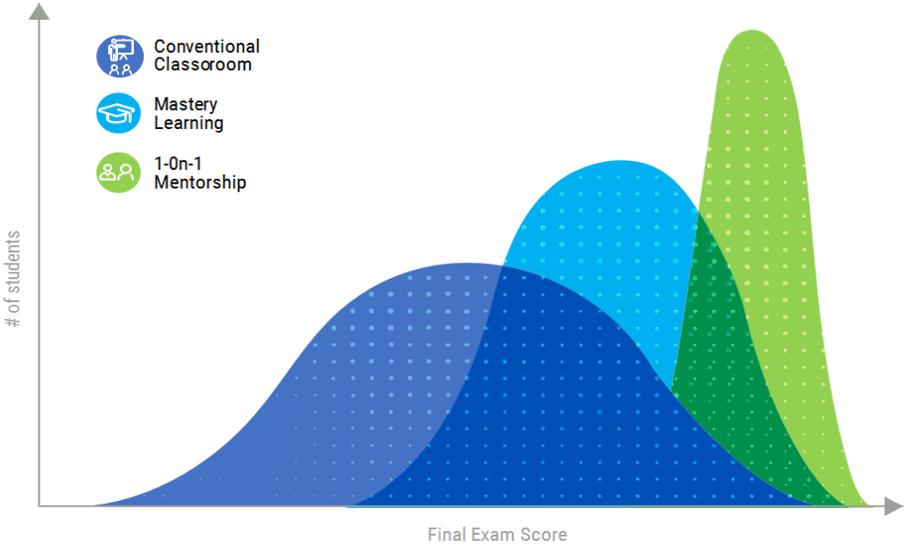
Mastery learning refers to the category of instructional methods which establishes a level of performance that all students must master before moving on to the next unit.

The notion of personalised learning is not new, but technology, particularly analytics and big data, enables mass personalisation in a way that has not been possible in the past. As Sal Khan discusses below, the flexibility that technology and flipped learning brings is that students do not need to settle for only absorbing 80% of the teaching material; when able to progress at their own pace, they can master 90%+ of the material.

Technology allows mastery learning at scale and the opportunity to move up Bloom’s 2 sigma problem into much higher outcomes as machines are increasingly able to identify knowledge gaps and suggest remedial material to compensate.

Bloom’s 2 sigma problem refers to an educational phenomenon observed by educational psychologist Benjamin Bloom, initially reported in 1984 in the journal *Educational Researcher*. Bloom found that the average student tutored one-to-one using mastery learning techniques performed two standard deviations better than students who learn via conventional instructional methods.

Exhibit 33: Bloom's 2 sigma problem



Source: Goldman Sachs Global Investment Research

We interview Sal Khan, the founder of Khan Academy, on the power of flipped learning to enable students to reach higher levels of attainment through mastery learning.

For the exclusive use of KATHERINE.TAIT@GS.COM

Scaling mastery learning with **Sal Khan**, Founder and Executive Director of Khan Academy



Q. Khan Academy has been heralded for proving how the concept of flipped learning can work. Can you talk us through what this means in practice and what it can offer in terms of better outcomes and affordability?

A. This term flipped learning got associated with Khan Academy but it's definitely not my idea. Back in early days of Khan Academy I was working on the software part of Khan Academy, where I felt a lot of family members had gaps in their knowledge and it was a friend's suggestion to start making these mini lessons on YouTube for my family, and one thing led to another and people other than my family started watching them. Fairly shortly after that teachers started to message me on YouTube and say 'Hey, you've already given a useful mini lesson on completing the square, which liberates my class time to do more problem solving inside of the classroom.' And that's where the flip happens.

The problem is that the information delivery happens at a fixed pace, one size fits all and a lot of the students are a little bit lost, or bored. Then when the student is doing the problem solving, they're doing that in isolation, so even if they might need help, there's no one to help. But when they were to flip that interaction, students can get the information delivery at their own time and pace at home, they repeat it, they're not too embarrassed if they have to review something from earlier grade levels and then in the classroom they can do more problem solving, interaction and projects.

If students can work at their own time and pace, why be satisfied with a student only understanding 80% or 90% of the material. Now, instead of holding fixed when and how long you did something and assuming a variable outcome, why don't you have a fixed 90% plus outcome and what's variable is when and how long the students work on it. And that's what we've been working on, our philosophical underpinnings is Benjamin Bloom's mastery learning, which showed that if you're able to do mastery learning in an adaptive framework, students are able to get a two standard deviation improvement.

Q. And to that point, what do you think is the role of a teacher going forwards? How does that role evolve?

A. Significantly – it allows the teacher to move to a much higher career path. So instead of lecturing, it allows a teacher to let students work at their own time and pace, remediate gaps so that the teacher can understand where those students are. They can do focused interventions where necessary. I can see who has mastered the concept and who is still working on it; maybe I can pair them up. Maybe I can pair people up who are working on the same thing. If I've seen that my whole class has already gotten through something, then that frees up class time for me to do something else.

If you think about learning, it's a whole spectrum of stuff – let's imagine a spectrum that goes from the left to the right. And at the left end would be like the very rote things, like memorization of facts, and as you go further to the right, they're higher order tasks getting things like entrepreneurship and creativity and an ability to contribute to society.

Teachers have always been frustrated that they want to go to that right end but there are so many students who need help on the left end that they never get there. Technology might be able to address some of the core skills gaps and it allows the teacher to be with students more. And then it also allows the teacher to go much more to the right in that spectrum.

Q. And what strikes me about Khan Academy is how it's proven the scalability of delivering this content in a really personalizable way. What other aspects of education are scalable, in your view?

A. One form of scalability is the one you're referring to, in which you can put this tool out there that can reach millions of people. The other form of scalability is what allows a teacher to scalably do mastery learning, which otherwise would have been one on one; now a teacher can do 30 or 35 kids in that framework.

I think peer to peer learning is also a huge opportunity that can be facilitated by technology but actually doesn't require any technology at all. You just need to say, 'Who needs help and who's ready to help? Especially at high school, there are students who are already quite empathetic and great communicators and know the material and can at least assist. And sometimes, when the material is fresher in their mind, they can form a better connection with their peer, who's struggling with the material and even the students, frankly, who are maybe not the best communicators yet, or not the most empathetic yet, that's a super important muscle to build. So it's not just that the recipients of the tutoring benefit but the tutors themselves benefit. That would build a muscle that right now the education system really isn't measuring but I think any of us in kind of the real world would say that, that ability to teach, to empathize, to communicate, is arguably at least as important, or maybe more important than whatever the academic topic you are trying to learn.

Q. Absolutely and on that point, how do you think that the testing system overall needs to evolve to better encapsulate those things, as well as the mastery techniques that you were talking about before?

A. What I would say about exams and standardized testing is it's always – you should try to measure important things if you can but you should always be conscientious that you're probably not measuring all of the important things and there tends to be a human instinct to over indexing on the thing that you can measure.

People often vilify tests; I would say tests are neutral to positive. They're giving you some data and no test is perfect but what is counter productive is when a test becomes an end all, be all, a defining characteristic of who the student or teacher is. At high school and college there's a lot of grade level testing – let's say we're in 7th grade; if you started the year at a 4th grade level and then you finished the year at a 6th grade level, you had an incredible year but that 7th grade assessment says that you're still not at grade level. Likewise, if you entered that 7th grade year at an 8th grade level and at the end of the year, you're still at an 8th grade level, so you really didn't progress at all, but it'll still show that you are rocking 7th grade.

Assessments can be really valuable as an input into personalized practice. So right now, 70% of American students take the PSAT and the MSQT. When students take the PSAT in the 10th or 11th grade, the score is linked to Khan Academy so it acts as a diagnostic for personalized practice. Then we can follow those students from the PSAT through Khan Academy to the SAT. We have the partnership with the College Board around being the official SAT practice, which allows us to leverage assessment in a more productive way. Right now more than half of the kids who take the SAT globally are using Khan Academy. So every year we just take a subset of those many hundreds of thousands of kids who take the SAT and starting with the PSAT, so we can do these efficacy studies on the scale of 200–300k kids every year, which would have been unheard of. So we've much richer data to understand what's working for them and what's not working for them.

Q. And that links onto my next question about data. Clearly Khan Academy must generate significant amounts of data. How do you use this to refine the product and continue on your mission to deliver improved student outcomes?

A. One of my hopes is that Khan Academy has that direct impact with students and teachers feeling they have more power to help students. I hope that, over time, Khan Academy has the secondary, tertiary value to the world, which is that it can become this really powerful research platform for understanding the best way for folks to learn. So right now we are able to use that data.

So right now we use that data to understand what engages students - say, 'Are they learning more? Are they learning less?' Our first order proxy is learning actions, time on site, return visits, better at correlating a lot of those things with learning games that we're able to do with third party efficacy studies. Looking at a diagnostic for where kids could start on Khan Academy and what they should work on but also as kind of a continuous feedback assessment loop so we can understand what type of pathways were most efficacious for those kids.

Q. And there are several studies that are pointing to declining attention spans in young people today and a lack of concentration. Do you think that's true and what do you think that means for learning and particularly online learning?

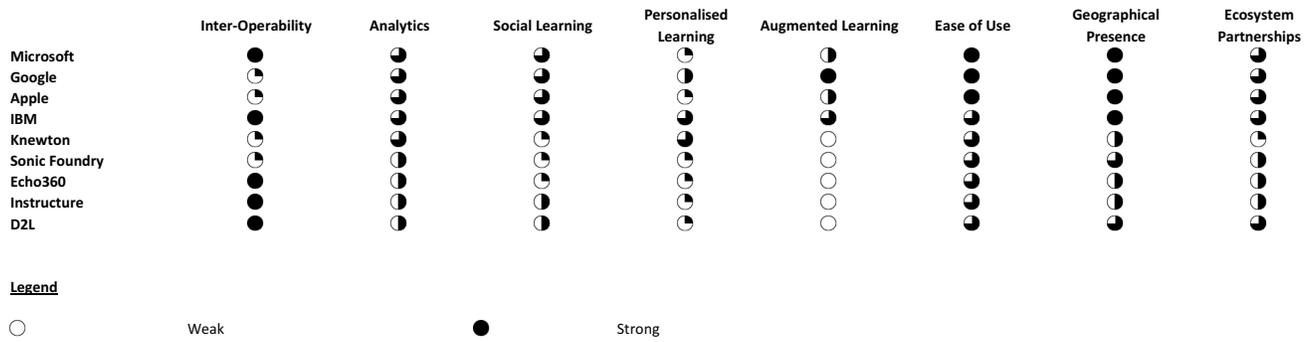
A. That wouldn't shock me. There are studies that go well before this current generation that showed that students in a lecture are able to focus for the first 10–15 minutes, then they zone out for about 5 minutes and then they zone back in but this time, instead of for 10–15 minutes, it might be 8 or 9 minutes, then they zone out and instead of 5 minutes, it ends up being 7 minutes. My understanding is the only reason why you have 60 minute classes, or 90 minute classes, is that's how long an hour happens to last and there's logistics of getting people from one class to another and that's probably roughly how long people can sit in one place without revolting or using the restroom. We can only really focus for about ten minutes.

A wide range of EdTech solutions are now on offer

Improved flexibility through blended learning methods and pure technology solutions (e.g. MOOCs) has reduced some of the barriers to individuals pursuing lifelong learning. While the EdTech industry is extremely fragmented, with start-ups across every part of the education eco-system, the larger platform companies such as Microsoft, Google and Apple are also clear players within the market. Given their scale in software, we expect platform players to continue to play a powerful role in institutions as they seek to improve their ability to analyse and personalise the learning experience for students.

iTunes U enables student access to apps, books, videos and podcasts from across iTunes. Meanwhile, it enables teachers to create lessons and build assignments that can immediately be shared with the class.

Exhibit 34: Feature strengths of platform players in education market
Global 2017



Source: zdnet.com, Goldman Sachs Global Investment Research

Company spotlight: Chegg; CHGG.K (Not Covered): Leading direct-to-student learning platform to improve educational outcomes

Chegg has been one of the key pioneers of developing technology solutions to help students achieve better outcomes. The company initially disrupted the traditional textbook market by driving the textbook rental model as a private company and in its early years as a public company. Since then, the company has transitioned into a direct-to-student learning platform that offers affordable subscription services to students to access its 26 mn question and answer repository, as well as offering on-demand online tutoring services.

We believe that the proliferation of learning apps will continue across different subjects, with K-12 based material the most popular on a global level. These apps operate a number of different free, paid and freemium models, while the traditional materials providers such as Pearson and Cengage have a less prominent offering in terms of web traffic. We have seen significant traction for services offering ‘tuition on demand’ either through connecting with tutors online, facilitated by players such as Chegg, or dynamic language practice with apps such as Duolingo. We also see the ‘gamification’ of learning, through companies such as 3PL, which instil a competitive dynamic to learning and practicing maths, as a growing trend.

Exhibit 35: Top learning websites and apps

Name	Languages	Popular Subjects	Free/Paid	Web Traffic (mn)	Global Rank	Category Rank
Udemy	English	On-demand skills	Free + Paid courses	110.1	321	1
Zybang	Chinese	K-12 subjects	Free	92.4	808	9
w3schools	English	Programming languages	Free + Paid courses	84.4	541	4
Duolingo	Multiple	Languages	Free	61.8	531	3
Khan Academy	English	Math, Science, Economics	Free	53.5	856	19
Blackboard	English	Multiple	Fremium	52.7	586	5
Coursera	Multiple	Math, Science, Technology	Free + Paid courses	37.0	1060	10
Brainly.in	Multiple	Multiple	Free	34.0	1967	19
Chegg	English	K-12, Higher Ed	Paid	25.6	1549	33
Course Hero	English	Multiple	Fremium	24.6	2553	26
EdX	English	K-12 subjects	Free	19.6	2611	69
teacherspayteachers	Multiple	K-12 subjects	Free + Paid courses	16.9	2148	21
McGraw Hill Education	English	K-12, Higher Ed	Paid	15.9	1882	18
Cengage	English	K-12, Higher Ed, Testing	Paid	13.3	3397	39
Pearson	English	K-12, Higher Ed, Testing	Paid	12.9	3582	43
Udacity	English	On-demand skills	Free + Paid courses	10.8	3928	46
Socratic	English	Higher Ed courses	Free	8.8	5000+	5*
Mathletics	English	Math	Free + Paid courses	3.4	5000+	134
SoloLearn	English	Programming languages	Free	3.2	5000+	221
Photomath	English	Math	Fremium	0.5	5000+	3887

* Maths category

Source: DigitalTrends, Android Authority, Similarweb, data compiled by Goldman Sachs Global Investment Research

Company spotlight: 3P Learning; 3PLAX (Not Covered): Mathletics Championships

3P Learning offers a specialised suite of learning resources used by 5 mn students in more than 17,000 schools, covering mathematics, spelling and literacy. The company uses 'gamification' techniques to encourage learners with 'Multiverse' for practicing multiplication and a 'Hall of Fame' that enables students to compete with other Mathletes around the world at any time.

What about Artificial Intelligence?

The potential for AI to disrupt the education space and the teaching profession is clearly significant. While we do not anticipate AI tutors replacing humans in the near or even medium term, we explore the potential for this technology to disrupt the existing system and highlight first-movers such as LAIX that have AI embedded deeply into their product.

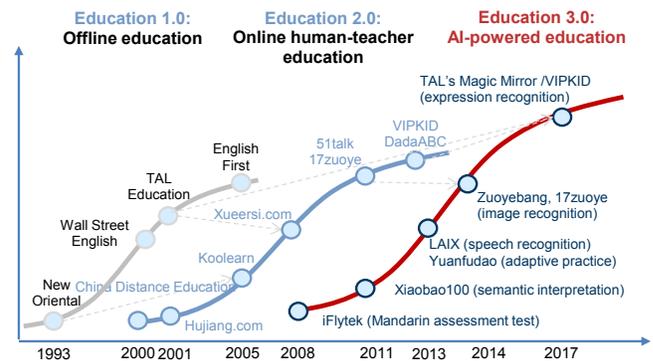
The use of AI within education could make it possible to deliver a personalised learning experience at a lower cost through large-scale data processing, deep analysis of user behaviours, speech recognition and automatic assessment, and algorithms that recommend the most suitable content and pedagogy.

Exhibit 36: Implications from a shift to AI-power education

	Education 1.0: Offline education	Education 2.0: Online human-teacher education	Education 3.0: Online AI-power education
Teachers	Human	Human	AI
Personalization	Low	At high cost	High
Learning venue	Physical	Online	Online
Learning efficacy	Low	Varies	High
Scalability	Low	Median	High
Operating cost	High	Median	Low

Source: LAIX, Goldman Sachs Global Investment Research

Exhibit 37: Illustration of companies across the AI spectrum within Education in China



Source: Company data, Goldman Sachs Global Investment Research

Company spotlight: LAIX Inc.; LAIX (covered by Christine Cho)

LAIX is an artificial intelligence (AI) company in China that provides subscription-based, personalised English learning products and services through its mobile platforms. Its proprietary AI-based learning platform feeds from the world's largest database of English spoken by Chinese learners and differentiates LAIX from its competitors, delivering efficiency and convenience at a lower cost to consumers. For more details please see our [initiation report](#).

The rising importance of career-long learning

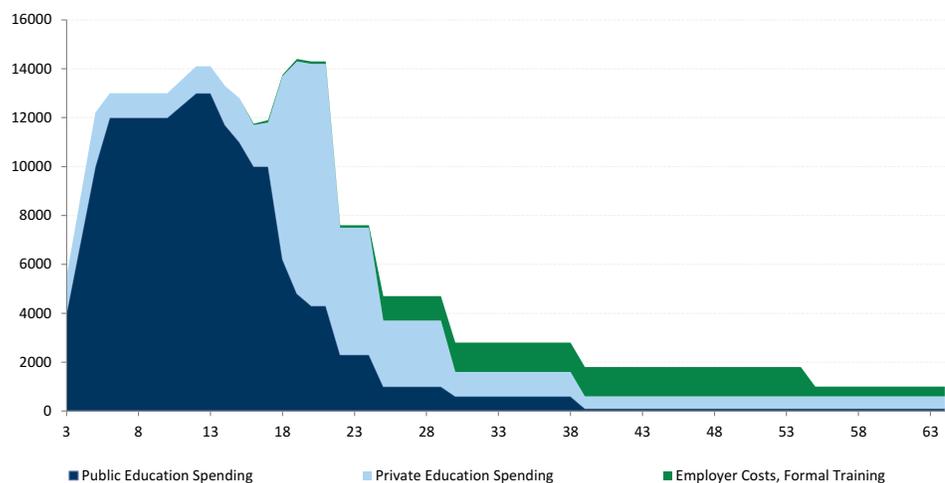
We believe that rising automation and use of technology in the workplace will require the labour force to shift more frequently, either in terms of occupation or skill-set, throughout their career. In our view, this is likely to drive an acceleration in corporate spend on reskilling and upskilling, as well as individual and government spend on lifelong learning. Key beneficiaries of this trend include HR Tech players and other companies that work closely with corporates on personnel can expand their offering to address skills gaps, such as staffing companies and employment classifieds platforms.

While the focus on learning and education is typically concentrated on school and university years, we also emphasise the importance of spend on training of the workforce.

Over the next 5 years, the US Bureau of Labor Statistics expects nearly 1/3 of the US workforce to transfer occupations into new career sectors.

As technology improvements and the rise in automation and robotics reduce the shelf-life of traditional skill sets over the coming decades, we expect individuals will transition more than ever between multiple career sectors during their lifetime. In our view, this will lead to a flattening of the 'learning curve', whereby structured learning continues throughout an individual's career rather than being skewed to the first 20 years or so of life. We highlight the examples of countries such as Singapore, which has established a Workforce Development Agency as part of its Ministry of Manpower and is committed to ensure working adults have access to high-quality, industry-relevant training throughout their lives.

Exhibit 38: Expenditure on education and skills training, by age and source
US\$ per capita, 2017



Source: OECD, US Census Bureau, US Bureau of Economic Analysis (BEA), BLS, CEA Calculations, Association for Talent Development, Carnevale et al

We believe that the nature of lifelong learning will be more skewed to specific skills, either by individuals or by corporates that perceive a recruitment gap in a particular area. We see companies that have close relationships with employers (e.g. staffers, employment classifieds, B2B publishers and HR Tech providers) as well placed to provide reskilling services. In our view, the moves by SEEK and Axel Springer into e-learning markets illustrate this trend. In our view, B2B publishers such as Wolters Kluwer, Informa and Relx are particularly well placed to provide training solutions to fill skills gaps within the specific industries they serve given their niche content offering and existing student-focused businesses.

While adult education offerings have typically been a stark choice between long open university or shorter vocational courses, we believe that 'just in time learning' through bootcamp-style training will become a more prominent solution. University Ventures recently reported that employers are spending as much as \$30,000 to recruit new software developers and as much as \$80,000 to recruit new nurses, paving the way for corporate solutions to meet these needs.

Company spotlight: Wolters Kluwer; WLSNc.AS (covered by Katherine Tait)

Wolters Kluwer, historically a leading publisher of medical and nursing textbooks has developed an integrated education platform combining the textbook content with adaptive learning tools. These tools include a virtual simulation training tool for new nurses to enable them to practice routine tasks such as taking blood etc.

Company spotlight: Learning Technologies Group; LTGL.L (covered by Katherine Tait)

LTG provides workplace digital learning and talent management services with a focus on developing its presence in highly regulated sectors where bespoke training is highly valued. We view the company as a key beneficiary of increasing corporate spend on workforce training and the shift to eLearning.

Randstad increased the number of hours of training per employee by 10 hours/annum between 2013 and 2017.

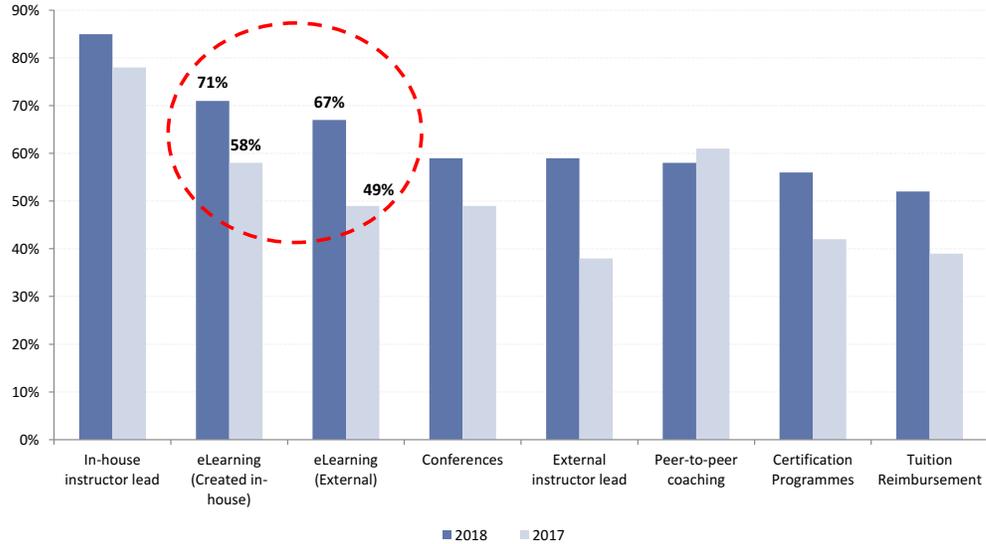
The trend towards lifelong learning is evident in the staffing sector, representing some of the largest private sector employers, which have a significant focus on hiring and training their employees. Several companies, which directly or indirectly employ several hundred thousand employees (for example, more than 500,000 people at staffing companies such as Adecco and Randstad, or some 300,000 people globally at outsourcing/customer care companies such as Teleperformance) see their internal training processes as a key point of competitive advantage.

Deutsche Post DHL, which employs 187k people in Germany, decided to reinvest c.€150 mn pa in training for its domestic German workforce after disappointing productivity growth in 2017/2018, which led to a profit warning during 1H2018.

Given the high churn rates in the sector (churn rate often exceeds 50% in a year), efficient and high-quality training is essential for keeping productivity high. Intertek, a testing company in Total Quality Assurance, recently acquired Alchemy (for an EV of close to US\$0.5 bn), which focuses on People Assurance Solutions, providing training/assurance via technology and remote learning modules for the food industry in particular (with some 400 training courses available, focusing in particular on areas such as food safety and workplace safety). We note that Alchemy has delivered 15%-20% organic growth in recent years.

Exhibit 39: Increases across eLearning and other forms of training suggest that upskilling is a focus of the workplace

What learning resource does your company use?

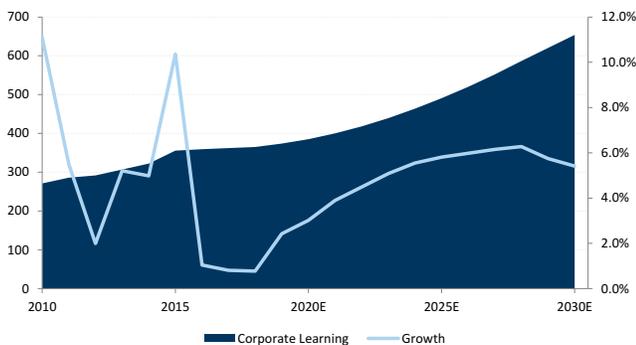


Source: LinkedIn, Goldman Sachs Global Investment Research

LinkedIn survey data also suggests that employers are seeking digital skills that colleges and universities are not addressing. In our view, the tech skills gap is not as simple as coding skills but reflects thousands of micro-level skills gaps. Entry-level positions outside the formal technology sector that manage functions such as supply chain, sales, marketing, customer service, finance, IT, and HR increasingly require skills such as Pardot (marketing), Marketo (digital marketing), Google Adwords (digital marketing), ZenDesk Plus (customer service), NetSuite (finance), Financial Force (finance), Workday (HR), and Salesforce.

Exhibit 40: We forecast the global corporate learning market to grow at a 5% CAGR in 2018-30E

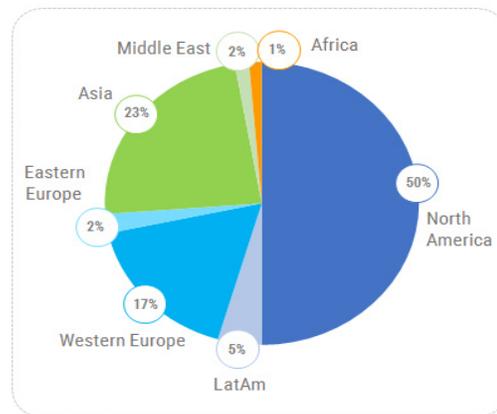
USD bn



Source: LTG, Goldman Sachs Global Investment Research

Exhibit 41: The self-paced eLearning market has typically been skewed to North America

Breakdown by geography, 2016



Source: Ambient Insight Research

Last-mile training refers to training focused on exactly the technical skills that employers need, such as coding or use of specific SaaS platforms.

We believe that adding last-mile training to staffing could enable staffing companies to provide employers with the opportunity to 'try before they buy.' These staffing models not only refrain from charging tuition, but also hire candidates from day one of training, thereby guaranteeing an employment outcome. This eliminates friction for employees who are considering reskilling but unwilling to take the full risk of leaving another job and paying upfront for tuition.

We forecast the corporate learning market to grow at a CAGR of 5% between 2018 and 2030, driven by population trends and an acceleration of spend per employee as the deflationary benefits of e-learning fade, while the skills gap necessitates corporates to engage in higher levels of training.

Exhibit 42: Induction training has become a higher proportion of overall training for staffers such as Randstad...

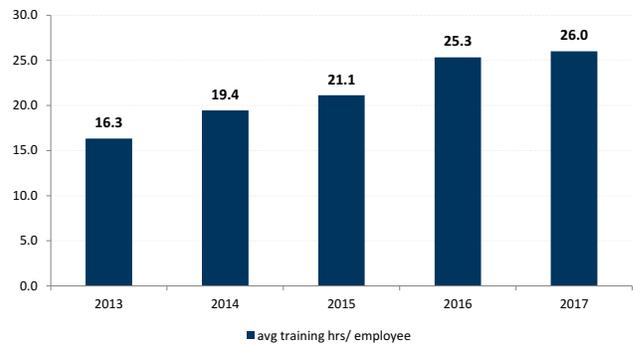
Employee training hours by type



Source: Randstad

Exhibit 43: ...and the average number of training hours has been increasing...

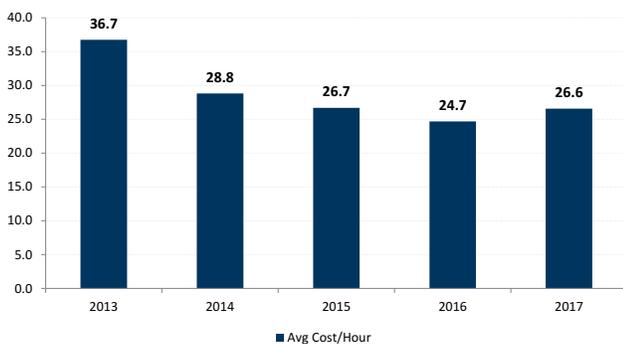
Average training hours/employee



Source: Randstad

Exhibit 44: ...while the cost per hour has been falling...

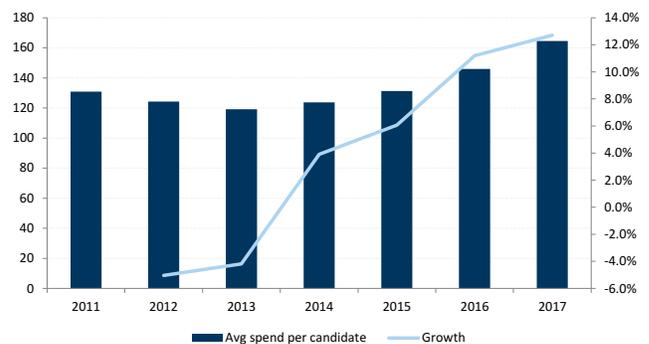
Average cost of training per hour



Source: Randstad

Exhibit 45: ...but overall spend per candidate has been increasing and accelerating

Average spend per candidate, 2011-17 in € mn



Source: Randstad

Tension in transition: How feasible is the pivot?

While this report has focused on the opportunities to improve both the cost equation and learning outcomes of education, we recognise that the reality of transition is extremely complicated. Challenges in the form of finite budgets, high initial hardware costs, a fragmented decision-making base, deeply embedded resistance to change among some participants, and the necessity to maintain an old system while implementing a new system all pose very real barriers to change.

We believe that before a full shift into 'The Future of Learning' that we have outlined takes place, there may be a transition period that requires a higher level of spend (as well as political and social buy-in) in order to ultimately allow for a less capital-intensive ecosystem to emerge. We also appreciate that the rapid pace of technology development may discourage schools from investing immediately owing to concerns that investments in today's technology may be obsolete tomorrow.

Despite the significant uncertainty in how governments, households and corporates will react to the upcoming challenges we have outlined, we believe that the areas set to take share of global education spend are corporate and career-long learning, and companies that offer technology solutions to reduce the capital intensity of delivering education.

In our view, innovation will likely begin in the areas where there is limited incumbency, such as lifelong and corporate learning, and come in the form of a modular introduction of parts of 'The Future of Learning'. As these business models scale, we expect broader adoption across the learning spectrum, even in areas currently wedded to incumbent models.

Appendix

Our global education model

We model the global education landscape from the top down, splitting the market into three components:

- 1. Government spend**, which includes current, capital spend and transfers, is sourced from the World Bank. We use our macro team's real GDP growth forecasts, adding US Core PCE to each growth rate to get to a nominalised USD PPP GDP growth rate. We then forecast government spend on a top-down basis using a % of GDP. Globally, we have seen a moderate upward trend in government education spend as a % of GDP, which we expect to plateau in the near term. We reflect this view over our longer-term and more granular forecasts.
- 2. Household spend**: We use data from the World Bank to generate our historical values for household education spend. For our forecasts, we normalise the data based on the population aged 0-64 in each region, using the underlying assumption that once someone has retired they no longer invest in education and development for non-leisure purposes. This provides us with a spend per capita figure, which we forecast to follow a similar development path to recent history.
- 3. Corporate spend**: We use industry data provider Training Industry for historical regional corporate education spend. We normalise the data using forecasts for population and those in economic activity from the World Bank to get to a corporate spend per employee number, on which we overlay our forecasts.

Exhibit 46: Key publicly listed education-based companies

Ticker	Company Name	Country	Market Cap (USD mn)	GS Covered?	Lead Analyst
TAL	TAL Education Group	China	21267	Yes	Christine Cho
EDU	New Oriental	China	12824	Yes	Christine Cho
INF.L	Informa	UK	12451	Yes	Katherine Tait
PSON.L	Pearson	UK	9418	Yes	Katherine Tait
BFAM	Bright Horizons	US	7452	Yes	George K. Tong, CFA
LOPE	Grand Canyon Univ.	US	5731	-	-
KROTY	Kroton	Brazil	4731	-	-
CHGG	Chegg	US	4547	-	-
SEK.AX	SEEK	Australia	4462	Yes	Kane Hannan, CFA
TWOU	2U	US	4153	Yes	George K. Tong, CFA
LAGA.PA	Lagardere	France	3626	Yes	Katherine Tait
UTG.L	Unite Students	UK	3148	-	-
0839.HK	China Edu. Group	China	3032	-	-
GHC	Graham Holdings	US	2968	-	-
ATGE	Adtalem Global Edu.	US	2777	-	-
IEL.AX	IDP	Australia	2687	Yes	Aaron Yeoh, CFA
ESTC3.SA	Estacio	Brazil	2243	-	-
PS	Plural Sight	US	2198	-	-
INST	Instructure	US	1634	-	-
LAUR	Laureate Intl. Univ.	US	1621	-	-
SEDU3.SA	SOMOS	Brazil	1532	-	-
1565.HK	Virscend Univ.	Hong Kong	1527	-	-
NVT.AX	navitas	Australia	1452	-	-
SCHL	Scholastic	US	1414	-	-
BEDU	Bright Scholar Education	China	1328	Yes	Christine Cho
1317.HK	China Maple Leaf Edu. Systems	China	1303	Yes	Christine Cho
CECO	Career Education	US	1165	-	-
1569.HK	Minsheng Education	China	973	-	-
HLG	Hailiang Education	China	912	-	-
6068.HK	Wisdom Education	China	910	-	-
HMHC	HMHC	US	882	Yes	George K. Tong, CFA
2001.Hk	New Higher Education	China	813	-	-
STG	Sunlands Online Education	China	720	Yes	Christine Cho
REDU	RISE Education	China	656	-	-
LTG.L	LTG Technologies	UK	632	Yes	Katherine Tait
LAIX	LAIX	China	513	Yes	Christine Cho
NEW	Puxin Education	China	502	-	-
7030.T	Sprix	Japan	378	Yes	Yukiko Nonami
TEDU	Tarena	China	330	Yes	Christine Cho

Source: Datastream, Goldman Sachs Global Investment Research.

Disclosure Appendix

Reg AC

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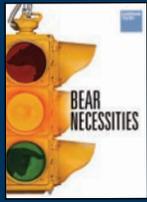


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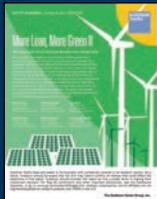


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From Pump to Plug



NextGen Power: Solar



Music's Return

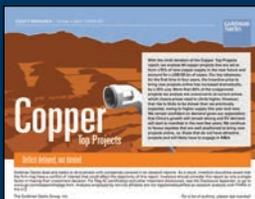


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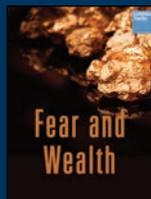
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