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Education and Training Ignite the **VR** Market

A Win-Win Opportunity for Telecom Operators and VR Players



STRATEGY ANALYTICS
Research, Experts, and Analytics



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01

Executive Summary

VR training and education can deliver lessons and training that are either not practical or even not possible in the real world. VR improves knowledge retention by bringing personal experience into training and education.

The education ecosystem is complex. Each country has its own unique education system and sources of funding. Education has been a significant focus of the Chinese government, and the available funding has been growing rapidly, making China one of the more attractive markets globally for VR education.

VR training for enterprises is typically bespoke for each client, unlike the education market where there is a standard curriculum. ROI must also be demonstrated for the company to invest in VR. Although a number of studies highlighted in this report demonstrate tangible benefits, the number of studies is low, showing a need for further research on the benefits of VR.

Despite being an early stage market, VR education is showing promising signs of market growth, including:

- The increasing investments governments are making in ICT in education, and particularly the Chinese government. Increased funding from governments and other institutions in both China and abroad will continue to grow this market in the coming few years.
- The traction shown by the various case studies. All of the companies highlighted in this report showed revenue growth.
- The availability of VR education apps showed a 292% increase in one year.

However, there remain bottlenecks in the market which may hinder growth. These include challenges related to the hardware and networks. Operators and service providers are therefore positioned well in the market not only to take a role but to help grow the market by overcoming these bottlenecks.

- Operators can play a role in device distribution, as they already do for mobile phones and other hardware.
- Taking a role in providing network connectivity to schools and other education institutions. This network capacity can be through improved fixed line infrastructure and WAN (notably 5G) deployments to improve the overall bandwidth available, vital for data-heavy VR applications. At a more local level, deploying next generation Wi-Fi infrastructure into buildings can facilitate the one-to-many simultaneous connections required for teaching entire classes of students in VR.
- Reducing hardware costs for all players in the ecosystem, further driving growth, by introducing “thin client” devices, enabled by shifting processing power to the cloud.
- Building a content service platform that can help content producers to reach more consumers. Users can easily access copyrighted and high-quality Apps, and pay for it, which in turn will promote VR education content development.
- Investing in cloud computing and CDNs at the network edge to ensure efficient content delivery.

02

Introduction

VR provides one of the most important aspects of learning that no other technology can match - experience. VR education can deliver lessons and training that are either not practical or even not possible in the real world.

In an educational setting, places can be explored as if students are actually there. They can interact with places and creatures they may never see in their lifetimes, and experience scenarios that are far too dangerous to do in real life. Imagine walking amongst dinosaurs or on the surface of Mars, exploring inside the human body or the structure of an atom. VR helps students feel immersed in ways not possible with traditional learning materials, and facilitates a higher level of knowledge retention. It is a technology that has the power to change how we learn. Schools and other educational establishments are already starting to use this promising new technology.

For businesses, using VR to deliver training can also offer many advantages. VR makes it possible to replicate a real-world experience, and practice it many times over without fear of mistake or injury. Workers can be trained in VR to gain experience in hazardous environments without risk, and some of the earliest adopters of the technology have been in the military and the construction industry. VR is being used to improve athletes' performance, and is enriching the flight simulator training given to pilots. Workers in customer support roles are being trained in VR to gain new insights and greater empathy, as it allows them to see things - literally - from a customer's point of view. As the benefits are becoming clearer, the use of VR in training is expanding across multiple industry verticals.

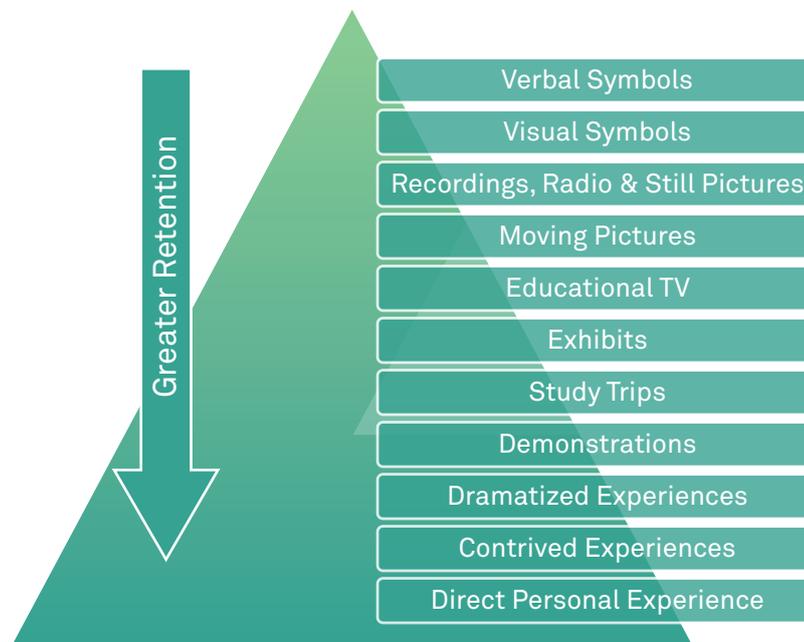
This white paper examines the major trends in the rapidly developing VR education and training fields, and identifies the opportunities to participate in and help grow this promising new market.

03

What Benefits Does VR Deliver?

VR is said to improve knowledge retention by bringing personal experience into classrooms and other training settings. In his Cone of Experience, Edgar Dale theorised that we retain much more knowledge when something is actually experienced rather than simply studied. This is often misquoted (with arbitrary numbers added) that “we retain 10% of what we read but 90% of what we experience”. Dale himself did not assign these numbers; rather he was proposing a theoretical model for improving learning through audio-visual material.

Edgar Dale's original Cone of Experience



One of the key advantages of VR is that it allows students and trainees to gain experience (albeit virtually), and so should improve knowledge retention. Dale's model seems intuitively correct, but are there data which can prove it? One of the challenges in VR education & training is the general lack of data to prove its value. This is not surprising in such an early stage of market development, but research into this area has begun and is beginning to demonstrate the value of VR.



3.1 Benefits in Education

▶ 3.1.1. Benefits for Students

The paper *The Impact of VR on Academic Performance* found that VR-based teaching improves both short and long term knowledge retention. In a test taken immediately after lessons, the exam scores of students taught using VR was an average of 27.4% higher than those taught using traditional teaching methods. The long term results were even more positive - in a test taken 2 weeks after the lessons, the exam scores of students taught using VR was an average of 32.4% higher.

In the paper *Is Virtual Reality a Memorable Experience in an Educational Context?* students were given various demos in virtual environments and in-person. They found that 88% of students remembered the demonstration they had in the CAVE virtual environment, compared to between 16-48% of students recollecting the various demonstrations given in-person.

In the paper *Virtual reality as a new trend in mechanical and electrical engineering education*, VR lessons were rated by various criteria. The most striking result was that 100% of students scored the VR lesson 5 out of 5 for the question "Is this kind of presentation useful for memorization?"

The report *The influence of long-time VR headset usage to underage users' eyesight* found that after participants wore VR headset for one hour, 90% of them shown an eyesight improvement or no changes. The result shown VR is health and safe for younger users.



▶ 3.1.2. Benefits for Teachers

Teachers may need to be trained to deliver lessons in VR, and their willingness to adopt the technology is extremely important if the market is to grow further. Although there is not a lot of research on the benefits of VR for students, there is even less on the benefits for teachers.

“The survey clearly shows that teachers are very open-minded when it comes to the implementation of new media in school. They recognize potentials unfolding with digital technologies such as VR... It is now a matter of enabling teachers to integrate them into the classroom.”

Steffen Ganders, Director Corporate Citizenship & Public Affairs, Samsung Electronics GmbH

The paper *Virtual reality as a new trend in mechanical and electrical engineering education* also asked teachers to assess and rate the VR lessons. As with the group of students, the teaching staff rated the VR lessons highly. In fact, teachers seemed to like VR as a teaching tool even more than the students. 100% of teachers rated the VR lessons 5 out of 5 across three different criteria: “Do you find this tool useful for presenting the exercises?”, “Do you find this tool useful in passing down knowledge?” and “Would you like to use the system as a part of your classes?”

A survey by KANTAR and Samsung in Germany found

that 79% of the teachers interviewed agreed that VR enables experiences that would not be possible otherwise. The majority of teachers believe that the use of VR in class can increase students’ motivation (74%) and improve their learning success (62%). Of the survey group, only 4% were working in schools already using VR, but 74% said that they would integrate VR into lessons at least once a month if the equipment were accessible by them.

▶ 3.2 Benefits in Industry

In the enterprise sector, it is largely through case studies rather than academic studies that the value of VR is being proven. Some examples which demonstrate tangible value include:

- **Health:** SimforHealth offers an immersive, interactive and collaborative approach to the VR training of healthcare professionals.

“The possibility simulation offers to create or recreate clinical situations will enable all users, students and health professionals to learn by doing. Through repetition and analysis it will strengthen their professionalism.”

Sophie Alex-Bacquer, Manager, French Red Cross

VR training for healthcare enables the emergence of a new rule: “Never the first time on the patient”. SimforHealth has been used as part of the training by over 30,000 healthcare professionals.

- **Construction:** United Rentals trains sales reps to rent construction equipment to job sites. However, using formal classroom training falls short of replicating actual jobsite experience. *United Rentals used VR to bring construction sites into the classroom* so that new sales reps are able to learn while feeling like they are on a site, but without actually being there. VR was found to be a more efficient learning tool and reduced training times by 40%.
- **Retail:** *Walmart used VR to create a next generation learning program*, including training in stressful environments such as “Black Friday”, the busiest shopping day of the year. 70% of the employees trained in VR did better in their exams versus the group that did not use VR, and employee training satisfaction was 30% higher for those trained in VR. As a result of the trial, the company extended its use and 150,000 employees were trained in VR in 2017.
- **Sports:** a number of *NFL and other American Football teams are using VR* to help players train without risk of injury, and make better decisions on the field by replaying key situations multiple times (“reps”). Stanford University’s quarterback’s passing completion numbers went from 64% to 76% and the team’s total offense improved from 24 points per game to 38 points per game during this same period after implementing VR training.
- **Customer Support:** *Fidelity Investments uses VR* to improve help its call centre operators become more compassionate. Now, instead of being instructed to empathize, trainees use virtual reality to have an experience that helps make them more empathetic, literally seeing things from a customer’s point of view. Fidelity has seen a 10% increase in caller customer satisfaction since beginning the VR training.

Although these studies are useful, they are rare and sample sizes are relatively small. More research can be done by institutions and companies in this sector to demonstrate tangible results from VR training and education.



04

The VR Education Ecosystem

4.1

Global VR Education Development

There is no real global education ecosystem. Each country, and sometimes even regions within a country, has its own unique education system. Different curricula overlaid on top of these different systems can make it very difficult for education providers in one country to address other markets. However, if there is anything approaching an international standard, it is K-12. The name comes from the typical 12 years of education many people receive, starting at kindergarten. The term began in the US, and is also used official in other countries. Other countries often have an equivalent system (such as “All Through School” in the UK) but K-12 is often used as a terminology even in countries where it is not an official government policy. It is a useful term to know when addressing international markets.

ICT funding for education also varies widely. Today, many



governments are investing to improve their education systems through the integration of ICT. Funding is sometimes from central government, sometimes through local education authorities, and often in partnership (or even led by) private companies. Taking perhaps the most extreme example (unsurprising since it is the world’s largest economy), the United States has funding available from many possible sources:

- *EdSim* challenge, funded by the Department for Education in partnership with private companies.
- *Small Business Innovation Research* program and also *multiple other grants* funded by the Institute of Education Sciences, which is itself part of the U.S. Department of Education.
- The *National Institutes of Health* (part of the Department for Health and Human Services) has grants for VR education in the field of healthcare amongst other topics (the 2019 topic list runs to 64 pages). Another avenue is to get funding via the Small Business Innovation Research and Small Business Technology Transfer Programs.
- The *National Science Foundation* has hundreds, if not thousands, of grants available including grants to enhance learning of K-12 and pre-school students through ICT.

- Universities such as *MIT* and *Yale* run VR education funding programs.

The complex environment for sources of funding for VR in education is a fairly typical pattern. Funding from government sources varies widely from country to country, with some governments (like China and the US) having multiple sources, but other countries investing little or nothing.

As well as individual country governments, some other organizations such as the European Commission also have sources of funding available. One example is the *Horizon 2020 program*, which aims to secure European competitiveness through innovation. Although it is not funding specific to VR, it has provided some funding to VR education projects, such as *REVEAL*. Besides governments and educational establishments, other sources of funding include programs run by VR hardware vendors, other companies in the ecosystem such as mobile operators, and venture capital funds.



4.2 VR Education Development in China

▶ 4.2.1. China Education Sector Overview

“In China, the VR education market is growing fast. In 2016, the sum of VR education projects in public schools (government sourcing) was RMB 600 million. In 2017, the figure was doubled to RMB 1.2 billion. I expect it would be doubled again in 2018 to reach around RMB 2.4 billion.”

Yang Wei, CEO, VRSCHOOL

Education has been a significant focus of the Chinese government. The education system in China is largely state-run and directed by the Ministry of Education (MOE). Official commitment to education was evident in the introduction of the Law on Nine-Year Compulsory Education in 1986. This saw a huge increase in funds for education.

In 1998 the government expanded university enrollment. Many educational authorities were restructured or merged, along with the educational institutions themselves. Higher vocational education was also restructured. Students in higher education have increased dramatically; there are now over

41.8M students at university or in other higher education institutions.

The education system is also being opened up to private institutions, and there are now some 48.3M students in China receiving a private education.

By 2016, there were already over 189 thousand primary schools, 77 thousand secondary education schools

and 3600 high education institutions in China, according to MOE. The total enrollments in China's education system has reached 225 million. It's indeed a huge education sector and has strong demand to continuously improve education quality and efficiency by leveraging new technologies.



► 4.2.2. ICT Education Funding in China

One of the most recent changes in education should help the growth of VR in that sector. The government's Ten Year Development Plan for ICT in Education means that by 2020, all adults will have access to quality education resources in an ICT-enabling environment and schools at all levels will have broadband internet access.

Some of this infrastructure has already been deployed in the form of China Education and Research Network (CERNet) and China Education Broadband Satellite (CEBSat), which are the two main education networks.

The government is also encouraging educational institutions to create "MOOCs" (Massive Open Online Courses) to encourage distance learning and address some of the education inequalities between urban and rural areas. By their nature, MOOCs mean that teachers may never meet some of their pupils face to face. They will only ever "meet" virtually.

These developments give educational establishments an imperative to deploy new technologies such as VR, and broadband access will mean that one of the enabling technology layers will be in place to support this.

On a national level, the Ministry of Industry and Information Technology (MIIT) established the *Industry of Virtual Reality Alliance* (IVRA) to grow the ecosystem. The alliance includes over 170 partners including private companies and academic institutions such as the Beijing Institute of Technology. The alliance also includes non-Chinese partners, such as Columbia University in the US.

Despite the national level, there is also activity on a local level. Examples include the Shenzhen Municipal Government *developing the China VR Research Institute*. The *Beidouwan Virtual Reality Town* is being created in the Guizhou Province backed by the Guian government. These are 2 examples of many, and each initiative will dedicate funding and resources to advance training and education using VR.

The overall picture of ICT investment in education in China is similar to that of funding for the education system generally. On the one hand, there is a lot of funding available and a strong government policy to invest in this sector. On the other hand, sources of funding can be difficult to find and can change rapidly.

"The biggest driver for VR education market is the education reform in Chinese public schools. These schools are transforming their education mode from traditional "force-feeding" to heuristic interactive teaching. In this transformation, schools have strong demand for new technologies and solutions to provide students new experiences.

But the government should increase funding to support VR education development, particularly content production, because today's market size is not enough to achieve sustainable growth."

Yan Hongwei, CEO, FLY VR

“A big issue is the scale of government funding. Many Chinese vocational schools have strong demand and sufficient budget to use new technologies in their professional classes. But public schools, particularly K-12 schools, can’t get enough budget to use the new technology.”

**Gao Feng, General Manager
Deputy, Eternity, NetDragon’s subsidiary
for education market**

Although governments are often perceived as being slow moving, when it comes to education, “The only constant in life is change”, as the Greek philosopher Heraclitus said. China is not alone in having many radical changes to its education system, although it is amongst the more extreme examples. Change happens everywhere, but in most developed countries with well-established education systems the change tends to be more incremental in nature. While in China the government is investing, and increasing its investment, in the education system, in other countries this is typically not the case. Changes are made to systems often without an increase in budget. So while the changes may be less radical, budgetary constraints can make them non less problematic to implement.

What this often means is that schools and educational establishments, particularly state-run schools, often do not have the resources to spend on VR equipment themselves. Funding must come from another source, often government departments and sometimes private companies. However, it can be extremely difficult for VR education companies to find these sources of funding, and it is a complex and challenging environment.





05

The VR Training Ecosystem

VR training for enterprises is typically bespoke for each client to suit specific needs, and to integrate into the company's broader training program. Companies looking to enhance their training programs will either develop them internally, or look for a partner to help them create a particular aspect of the program. The examples in section 3.2 were all created working in partnership with a specialist VR training company.

In this sense, the companies involved in the VR training market are more like specialist “developers for hire” creating a bespoke solution for each client. Some companies have attempted to productize at least some of the assets; examples of this include STRIVR and Virtualis (company profiles can be found in section 6.2). This approach allows them to create training programs quickly and efficiently, although a high level of customisation will typically be required for each client.

However, although the value chain is simple, once again, companies looking to move into provide VR training for enterprises face several challenges.

- It's not like the education market where there is a standard curriculum, at least for K-12 education. A high degree of customisation will be required by each enterprise.
- Education systems are often primarily state funded. Government initiatives to drive adoption of VR (or the adoption of ICT more broadly) into the education system mean that there can be a culture which is very receptive to new technological innovations. In contrast, while some companies may have a similar culture, this can vary widely. Even where a company may have a culture of innovation, VR training programs are likely to be expensive to implement. A return on investment must be demonstrated for the company to invest in VR training programs.
- Typically the only source of funding is the company commissioning the development of a VR training program. Sources of public funding are exceedingly rare.

06

VR Education & Training Provider Profiles

As discussed in previous sections, the markets for VR education and VR training are very different, with a different client base, different funding and different business models. So despite many similarities in terms of technology, the typical pattern is that companies act as providers of either VR education or VR training, but typically not both.

6.1 Education

6.1.1.VRSCHOOL

Focusing on K-12 and vocational education, VRSCHOOL provides a complete VR teaching solution to schools and further education establishments in China. A “VRmaker classroom” of PCs and VR headsets can be deployed in schools.

As well as the hardware, the company provides a range of education software, allowing teachers to begin using VR immediately. The software includes a VR content production engine and class management system. The engine can help students to develop their own VR contents. The production process could improve student’s creative thinking, understanding on art and logics, as well as teamwork spirit. The class management system enables teachers to manage and control the learning experience and student’s behaviour. VRSCHOOL also provides value added services, such as class development and teacher training.



Traction: Currently, the hardware generates around one third of total revenue, and software and content contributes the remainder. The company has achieved positive cash flow in 2017, and expects the overall market to double in the coming year.

▶ 6.1.2.FLY VR

FLY VR provides a total solution including hardware, software and content for K-12 school market. FLY VR also provides additional services such as content subscription. FLY VR's hardware products include the VR headset, AR smart desk and 3D light immersion solution. FLY VR's software includes the content, class management and device management. The solution facilitates one to many teaching, but also one to one. Control and teaching tools allow for classroom management by teacher. The content has a focus on science and vocational education, also other aspects of school life such as fire and earthquake drill practice.

FLY VR develops education contents by themselves and also partners with some content producers. The company has built many partnerships for hardware (HTC, Dell, Oculus), software (Unreal, Unity), as well as strategic education partners such as schools, universities, and government and provincial education agencies.



Traction: FLY VR's revenue was up to RMB 70 million in 2017. The company has around 140 K-12 customers, including around 40 “pilot schools” and around 100 paid customers. FLY VR has also done hundreds of VR education projects for vocational schools or colleges.

▶ 6.1.3.NetDragon

Better known as a games developer, NetDragon Websoft Holdings Limited has used its expertise in creating 3D environments to move seamlessly into the education sector. 2016 was the first year the company's revenues from education overtook revenues from what was previously its core gaming business.

NetDragon's focus in VR education is mainly on the VR professional education and developer training, while they are also using VR to improve regular (K-12) classes. NetDragon is collaborating with China's Ministry of Education (MOE) for the Vocational Student VR Skill Competition, and more than 300 vocational schools are involved. NetDragon is working with MOE to establish VR labs in colleges for teacher's training and support VR start-ups by students. MOE has provided RMB 260 million funding for the VR labs, with a target to establish 200 labs in Chinese colleges. NetDragon founded a VR Education Alliance for the continuing education schools. The schools in the alliance can share VR education content to accelerate the adoption of VR education.

NetDragon also develops some VR education content, particularly for vocational schools, such as the VR classes for high speed train maintenance, and human anatomy. In the K-12 market, NetDragon is collaborating with local government to develop VR classes, mainly for science education. An example is the VR assisted biology class in all middle schools of Shanghai. However, only 10% of NetDragon's education revenues were from this market.

Traction: NetDragon's overall education business (including VR but also other education technologies) recorded revenue of RMB 2,105M for the year 2017, up 37.9% year-over-year. In China, revenue increased at an even faster rate, by 82.2% year-over-year to RMB 329.5 M.

► 6.1.4. Idealens

Initially Idealens' business focused on VR headsets. But in VR education market, the margin of hardware business is too low, and software is an important component. So the company developed its software, and its system integration and solution business. This allowed them to achieve fast growth. Currently they focus on K-12 schools because the number of K-12 schools is large, and the content for K-12 market is almost standardized.



A class using Idealens solution

Idealens has set up a VR teachers alliance to share the experience and lessons about VR education. Idealens also provides a VR content editor to teachers to encourage teachers to create their own “UGC” content and learning materials.

Traction: In 2017, the solution business achieved around RMB 20 million revenues, accounting for about 40% of total company revenue.

► 6.1.5. Google Expeditions

Google Expeditions is a VR platform focussed on allowing students to take “virtual field trips”. Expeditions allows a teacher acting as a guide to lead classroom-sized groups of explorers through collections of 360° and 3D images while pointing out interesting sights along the way.



A class using Google Expeditions

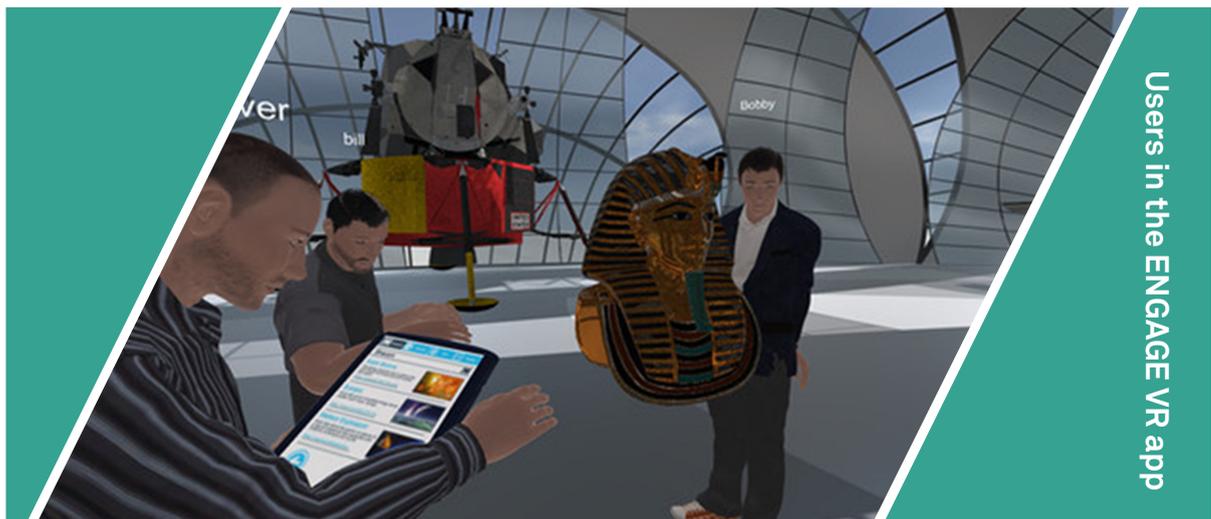
The video and images, along with additional educational data points for specific locations in the environment, are produced by Google and partners. Partners for content creation include American Museum of Natural History, Chateau de Versailles, National Geographic, National Museum of Korea, and the WWF.

Expeditions runs on smartphone-based VR headsets such as the Google cardboard. This is potentially a very low cost solution for hardware - as long as students can provide their own smartphones. Distribution of “Expeditions Kits” is handled by local partners, such as Best Buy in the US and Redbox in the UK. These kits include not only the viewers, but also smartphones, a tablet for the “guide” (i.e. the teacher), a router and a case which can charge the devices simultaneously.

► 6.1.6.VR Education Holdings

VR Education Holdings is a VR software and technology group based in Waterford, Ireland, dedicated to transforming the delivery methods of education and corporate training by utilising VR technologies to deliver fully immersive virtual learning experiences.

The Group's core focus is the development and commercialisation of its online virtual social learning and presentation platform, ENGAGE, which provides a platform for creating, sharing and delivering proprietary and third-party VR content for educational and corporate training purposes. It allows multiple users to have a virtual presence using avatars in multi-user VR environments. In essence, ENGAGE is a multiplayer VR “game” but with the addition of features aimed at teaching, such as an interactive whiteboard, presentation capabilities, and file sharing.



The ENGAGE platform has been designed to overcome certain limitations of currently available online courses, known as MOOCs, and traditional learning methods by allowing for virtual face-to-face education and training in a variety of environments regardless of the geographical location of the user.

ENGAGE is currently in “alpha” stage of development, but has already been used by the University of Oxford to help train medical professionals. VR Education Holdings also has some education apps already in the market. They include the Apollo 11 and Titanic VR exploration apps aimed at the education market, and a medical training app developed in conjunction with the Royal College of Surgeons in Ireland.

Traction: the company achieved just under €0.5M revenues in 2016, and is on course to grow revenues by 25% in 2017. The Apollo 11 app has been downloaded over 80,000 times.

6.2 Training

▶ 6.2.1.STRIVR

STRIVR was created by an expert in virtual reality and a football coach together at Stanford University. It has since broadened its customer base beyond football to other sports, and into other industry verticals as well. STRIVR's product for enterprises has three components. The "Creator" allows organisations to set up virtual training environments and construct training programs. The "Classroom" is the app that employees actually use for training, and finally the "Analyser" allows trainers to measure the performance of the students and produce reports.



Traction: Since 2015, STRIVR has grown its client base to 50 businesses across multiple verticals including sports (including various NFL and college football teams, and MLB), retail (Walmart, Lowe's), and finance (VISA, Fidelity Investments).

▶ 6.2.2.Innoactive

Initially creating VR collaboration tools for enterprises, Germany's Innoactive has also begun developing VR training programs. In order to productise its VR training, the company can provide clients with the tools to build their own training programs with its own editor, and for more advanced use cases, an SDK for popular third party VR development toolkit Unity.



Traction: A major client is Volkswagen Group, which will bring VR training to 10,000 employees of Audi, SEAT, ŠKODA and Volkswagen brands. Over 30 VR training experiences cover a broad range of skills from vehicle assembly to customer service.

07

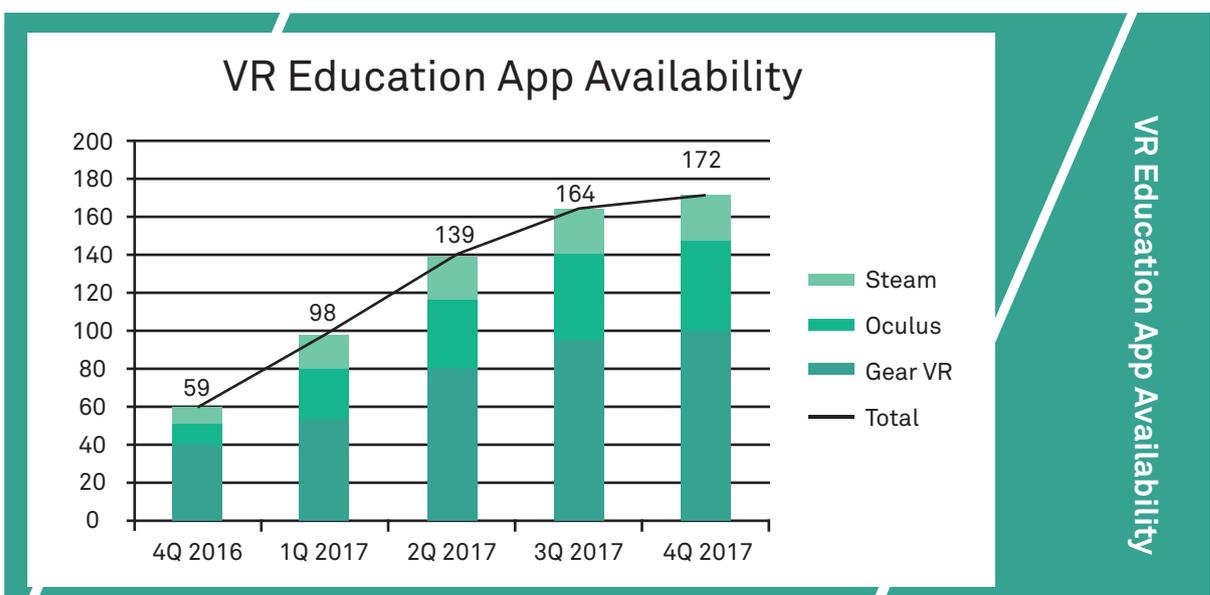
VR Education App Distribution

Since VR training apps tend to be bespoke pieces of software for specific companies, public distribution is rare. However, there are some types of training that can be standardised across multiple companies. An example is *Diversifyly's* diversity training, and the app is distributed via consumer-facing app stores. However, examples like this are rare for VR training. For VR education, as well as working with education institutions directly, some providers also use consumer-facing app stores for distribution.

7.1 Education App Availability

The selection of VR apps currently available to end users through dedicated VR app stores sheds light on how the VR education market is developing. Strategy Analytics has collected data from the top international dedicated VR app stores, including the stores for Samsung Gear VR and Oculus Rift, and the VR apps available via Steam. These stores have a dedicated Education category, allowing us to track the development of this market over time.

Education is consistently the second largest app category (after games). The availability of VR education apps has grown at a very fast rate - from only 59 apps to a remarkable 172 apps, which represents a 292% increase in one year.

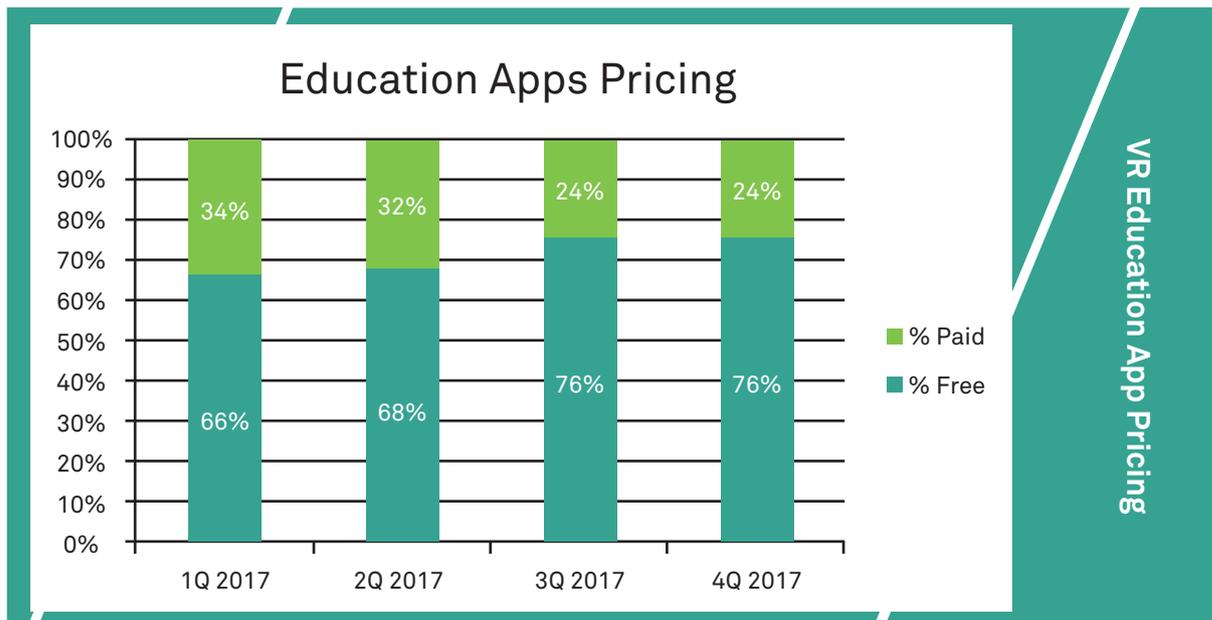


This growth in app availability demonstrates the strength of the VR education market. Although the total number of apps may seem relatively low, it is worth bearing in mind that not all VR education providers use public-facing app stores for distribution. Each single app also typically provides multiple courses and topics, so the count of apps significantly underestimates the broad range of educational content available.



7.2 Education App Pricing and Business Models

Pricing data from the app stores also helps to demonstrate how education apps' business model has slowly changed over time. Free apps are consistently the largest proportion, and the % of free education apps has been increasing over time, growing from 66% to 76%.



Why so many free apps? Isn't anyone making any money? Actually, the opposite is true, and "free" has become an important business model for apps across all categories. "Free" does not always mean "completely free". Free distribution can be monetized through different business models:

- For some companies, free apps are an important part of marketing activities. Media companies create free apps to support their content brands. For example, broadcasters who are creating educational programming might also create free education apps for marketing those brands. Some of the free VR education apps are from the BBC, Discovery and other broadcasters. This type of activity is helping the overall VR education market to grow by allowing educators to try out VR apps and see the benefits.
- Apps can be free to download but subsequently generate revenue through either in-app purchases or the delivery of advertising within those apps. Including advertising is likely to be seen as a negative by educators. However, in-app purchases are common for education apps aimed at students (rather than

schools or other educational establishments), typically allowing students to download additional course material. A language app might have some basic content for free (learning to say hello, or counting to 10) but require in-app purchases to download extra modules to continue learning.

- Apps may be free to download but require the user to have a paid subscription to fully access the content. This is the major business model being used today by VR education apps. Some of the case studies, including VR Education Holdings, are using this business model. In effect, they are using app store infrastructure as a cloud distribution channel. This helps them build their business by increasing the distribution channels available and means that these companies do not have to invest as much in their own cloud infrastructure. For the providers of the app stores, hosting free apps is a tiny incremental cost. Anything which increases the number of apps available to their consumers is important for their marketing and helps “lock in” customers to their ecosystem. So this is a “win win” scenario for VR education app providers and VR app stores.



08

Bottlenecks and Challenges

As discussed in the Ecosystem sections, proving the value of VR in the enterprise sector is a particular challenge for training. Funding is the main challenges facing VR education companies today. But what other issues are there? Although VR education and VR training are different markets, they share together the other issues they face.

8.1 Content

“The content is limited. There are no 'systematic VR textbooks' yet, and so the existing VR lessons are nothing more than test pieces.”

Professor Huang Ronghuai, Smart Learning Institute at Beijing Normal University

Developing content in VR is not a trivial undertaking. As a result, much of the content provided today is professionally generated. This is expensive, driving up costs. It typically also means that the lessons in VR are not being created by the teachers who will be guiding pupils through the lesson, which can lead to subsequent problems.

The content created may also be difficult to standardise.

As noted earlier, each country has its own curriculum, so content developed for China may not be useful when addressing the education market in the USA. This can make it difficult for companies to operate outside their home market.

Standardisation of content can exist within one country, but typically only for K-12 content. The school curriculum for that age group is usually standardised at a national level. However, for higher education, and for vocational courses, the curriculum is rarely standardised. Content creators may have to produce specific VR education content for each customer. This drives up costs, and may price VR education solutions out of the budget of many schools and colleges.

Creating the content is more challenging for higher and vocational education, where there is much less standardisation of curriculum materials than for K-12 education. Here, providers for both VR education and training face similar challenges around creating customised content for each customer. As shown in the provider profiles, enterprise VR training providers are aiming to overcome this by creating development toolkits for their customers to use.

In addition to generating content, another challenge is protecting it. One way of protecting copyright, particularly for the education sector, is to take a cloud delivery approach. It is easier to secure a server than potentially hundreds of individual devices.



8.2 Hardware

▶ 8.2.1. Cost

One of the issues today is the cost of VR hardware, particularly in the education sector. With limited budgets and sources of funding, schools cannot all afford to install VR classrooms. Most education apps are also aimed at “high end” VR headsets such as the HTC Vive. While there are some education apps targeting lower cost hardware, most notably Google Expeditions, the limited technology also puts restrictions on the learning experience and therefore the benefits provided. Expeditions only allows for very simple interactions – moving around a 360 environment and receiving some additional data on specific points of interest.

▶ 8.2.2. End-User Pain Points

Strategy Analytics has compiled consumer feedback from owners of a range of VR headsets. What are the key “pain points” for end users – the students themselves?

- Nausea is a common complain across all devices, and is a typical consumer pain point about VR in general. We also find a correlation between the type of content and the level of nausea. Content where the user

remains in a static position (such as video) led to fewer complains, compared to apps which involve a high degree of motion (such as driving games).

- For smartphone-based VR, the most common complaint was heat. VR content typically uses the maximum capabilities of the smartphone, generating a lot of heat and draining the battery.
- For more advanced headsets, the most common complaint was the difficulty of setup. In order to provide a high quality experience with rich user input mechanisms, devices use “outside in” sensors which must be placed around the room by the user and calibrated before use. This may cause issues when setting up a classroom for a VR lesson.
- The cable was an issue for users of PC-tethered VR headsets. Cables can become a trip hazard as users move around. Also, several users noted that the cable felt heavy, particularly after prolonged use. This may limit the length of lessons in VR.

“The quality and experience of VR hardware is a bottleneck. Particularly in K12 schools, parents and teachers usually have concerns about the impact of VR headset on student’s vision.”

Yang Wei, CEO, VRSCHOOL



8.3 Network

In education, class sizes can vary significantly. In K-12 equivalent education in China, class sizes of 45 or more are not uncommon. In the enterprise sector again there is wide variety, but the numbers of user being trained simultaneously can reach even greater figures. 45 or more simultaneous connections streaming VR content generate very high pressure on the network.



8.4 Who Trains the Trainers?

Much of the focus on VR education has been on the benefits to the pupils. However, schools must also provide training for teachers. Typically an older demographic than their pupils, not all teachers will be familiar with VR technology, and training will add to both the cost and time required for successful VR deployments in both education and enterprise.



09

Opportunities for Operators

9.1

Market Growth

VR education and training are markets experiencing growth, and service providers should seriously consider how they can take a role in growing and supporting market development.

Despite being a relatively early stage market, VR education is already showing promising signs of market growth. Key signs include:

- The increasing investments governments are making in ICT in education, and particularly the Chinese government, as detailed in section 4.
- The traction shown by the various case studies.
 - VRSCHOOL achieved positive cash flow in 2017, and expects the overall market to double in the coming year.
 - FLY VR's revenue was up to RMB 70 million in 2017.
 - NetDragon's education revenues have overtaken what was its core gaming business. Revenue grew 37.9% year-over-year to RMB 2,105M for the year 2017.
 - Idealens VR education solution business achieved around RMB 20 million revenues, accounting for about 40% of total company revenue, up from zero two years ago.
 - VR Education Holdings achieved just under €0.5M revenues in 2016, and is on course to grow revenues by 25% in 2017.
- The increased availability of VR education apps, from only 59 apps at the end of 2016 to 172 apps at the end of 2017, a 292% increase in one year.

Increased funding from governments and other institutions in both China and abroad will continue to grow this market in the coming few years.

Market growth in the enterprise sector is harder to quantify, but the rapid growth in the client base of the companies in this sector demonstrates that it is a market also on a significant upwards trajectory.



9.2 Overcoming Bottlenecks

Operators and service providers can play a role overcoming some of the bottlenecks and challenges facing the market today.

As discussed earlier, cheaper but limited hardware such as Google Cardboard limits the value of the education delivered via VR. Operators already play a role in distributing other categories of devices to enterprise consumers. Operators can therefore also play a role through hardware distribution.

Furthermore, operators can leverage network assets to reduce the cost of VR to end users. This can be done by distributing “thin client” hardware in combination with cloud technology, although the appropriate network features need to be in place to support content delivery to such devices.

Cloud VR delivery can decrease equipment costs and help drive the market. If the computational power is shifted from the device and into the cloud, the VR headset can be little more than a screen and a network connectivity module (a “thin client”). Educational institutions need not already have (or need to purchase) a high-end PC in order to deploy VR education content.

A particular challenge with “tethered” VR headsets (i.e. those attached to a PC or console) is the lack of both mobility and portability. The cable also causes comfort issues and adds extra weight, which can limit time spent using the device. Using a network to transmit data over the “last 1m” from a device to the headset can therefore improve the user experience. Service providers can improve this aspect of VR delivery. This could be through the use of mobile networks, especially 5G. For fixed line operators, this can also be achieved by providing schools and enterprises with routers featuring later generation Wi-Fi capable of fast data transfer speeds required for VR apps.



9.3 Telecom Operator’s Role in the VR Education Ecosystem

The growth of global connectivity market has been flat. Strategy Analytics forecasts the global wireless service revenue will grow 1.1% in 2018 as revenue per subscription falls by 2.2%. By 2023, the CAGR of global wireless service revenue will be just 0.6%. In residential broadband market, the CAGR of global service revenue from 2017 to 2023 will be only 2.4%. Therefore, telecom operators have to seek new growth sources to keep their businesses sustainable. VR education – with good growth potential – is a valuable vertical sector for operators.

On the other side, VR players are facing some challenges, as discussed in above section. Telecom operators can leverage their resources to help VR industry to overcome these bottlenecks and accelerate the VR adoption. So telecom operators and VR players can build “win-win” collaboration in VR education market to benefit both parties.

Network operators could potentially open up some of the network to trusted VR training and education providers. Since VR education and training is typically a “one to many” interaction, there may be many students taking part in lessons simultaneously, placing high demands on the network. This could not just be in a classroom or training facility, but also delivering VR to multiple locations at once to provide remote learning, or remote training. This particular market segment for education in particular is likely to grow through MOOCs, which are being promoted by governments in China and abroad to improve access to learning for remote communities. Guaranteed Quality of Service on the network may be important and gives service providers a USP if they wish to address this market.

There are other elements of cloud computing which operators can put in place to facilitate VR education, such as providing content editing or storage capacity, and CDNs closer to the edge of the network can lower latencies. CDNs also play a role in content creation so operators can place themselves in a good position not only for enhancing distribution but also providing services to content creators.

Finally, many service providers and mobile operators have, by necessity, become experts in mobility device management and running secure cloud infrastructure. This can allow operators to take a role in ensuring copyright protection and secure delivery of proprietary training materials.



9.4 How can Operators Participate in VR Education Market

- The market is growing and will continue to grow as governments and other institutions invest further in education ICT. Operators should seriously consider what role they can take in this ecosystem.
- Operators can play a role in device distribution, as they already do for mobile phones and other hardware.
- By using network infrastructure and other assets, operators can participate in and grow the market by:
 - Taking a role in providing network connectivity to schools and other education institutions. This network capacity can be through improved fixed line infrastructure and WAN (notably 5G) deployments to improve the overall bandwidth available, vital for data-heavy VR applications. At a more local level, deploying next generation Wi-Fi infrastructure into buildings can facilitate the one-to-many simultaneous connections required for teaching entire classes of students in VR.
 - Reducing hardware costs for all players in the ecosystem, further driving growth, by introducing “thin client” devices, enabled by shifting processing power to the cloud.
 - Building a content service platform that can help content producers to reach more consumers. Users can easily access copyrighted and high-quality Apps, and pay for it, which in turn will promote VR education content development.
 - Investing in cloud computing and CDNs at the network edge to ensure efficient content delivery.

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