A Case Study - The Impact of VR on Academic Performance

✧ **Participants**

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Abbreviations

Abbreviations and Terminology	Description
VR	Virtual Reality
Subjects	Persons that are experimented on
Immediate Test	Test in the same class
Retention Test	Test two weeks later
VR Group	Group that receives VR-based education
Controlled Group	Group that receives traditional education
VRIT	VR group, immediate test
VRRT	VR group, retention test
CIT	Controlled group, immediate test
CRT	Controlled group, retention test

Introduction

2016, known as the Virtual Reality boom year, has seen Virtual Reality emerging in enormous popularity in China. As the VR industry grows, the importance of VR content is more and more valued. VR content creators are not limiting their focus on games. Some of them intend to expand VR application to education. VR-based education is deemed as a field with huge potentials and has evolved from “concept phase” to “implementation phase”.

Compared with traditional education, VR-based education is of obvious advantage in theoretical knowledge teaching as well as practical skills training. In theoretical knowledge teaching, it boasts the ability to make abstract problems concrete, and theoretical thinking well-supported. In practical skills training, it helps sharpen students’ operational skills, provides an immersive learning experience, and enhances students' sense of involvement in class, making learning more fun, more secure, and more active.

1. Background

The education system in China is in a new development phase. However institutional problems occur frequently, resulting in great barriers to students' overall development. Actions should be taken to address those problems immediately.

Most students lack interest in boring teaching and learning. They are easily distracted if the knowledge taught in class is dry and plain. Despite the application of online education and seemingly vivid educational animation developed and introduced in the past years, the problem remains unsolved.

The charm of VR lies in its ability to simulate the real world, interact with the user, and create plots. VR can simulate great learning scenarios and facilitate the communication expression and application of knowledge, thus effectively creating a favorable learning environment where students are inspired to learn.

Astrophysics, a major branch of astronomy and physics, is a science that adopts the research techniques, methods, and theories in physics on the analysis of celestial body in terms of its shape, structure, physical condition, chemical composition and evolution law. The sixth chapter in the high school physics textbook is about Laws of Gravitation and Aerospace. It involves celestial physics which is abstract and hard for the students to understand. By presenting to students those abstract contents in the textbook in a three-dimensional way, VR takes the advantage of helping students better understand and acquire the knowledge.

2. Experiment Objectives

This experiment aims to show the difference between traditional teaching and VR-based teaching in students' celestial physics learning.

Examinees, divided into four groups, will carry out two tests in different time. One group will adopt VR-based teaching in the first test, and the other group, the traditional teaching. An Immediate Test will be taken after the teaching to show the difference between the two groups in their academic performance as well as learning efficiency. The second test, i.e. Retention test will come two weeks later to see how long the two groups can retain the knowledge.

3. Experiment Procedure

3.1.Subject

Subject selection criteria:Subjects are from full-time high schools in Beijing; The ratio between male and female students is about 1:1; Their academic grades range from A to C; subjects are divided into four groups.

Before the experiment, subjects are required to fill out a questionnaire, and then all of them will be divided into four groups based on their gender and physics test scores. The composition of these four groups stays relatively the same. # 3.1-1 shows the actual grouping info.

3.1-1

Group	Description	# of People

VRIT	Take test immediately after the VR-based teaching	10
VRRT	Take test two weeks later after the VR-based teaching	10
CIT	Take test immediately after the traditional teaching	10
CRT	Take test two weeks later after the traditional teaching	10

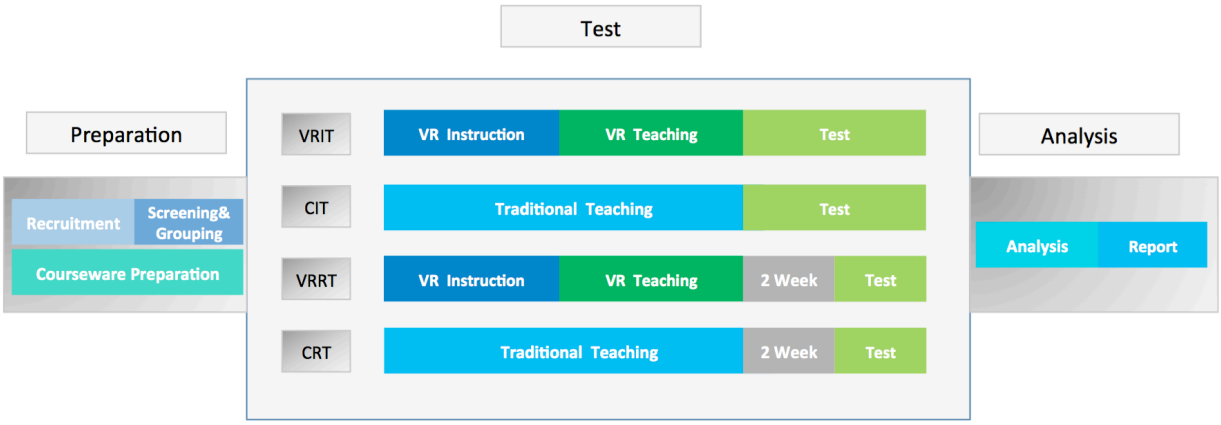
3.2.Experiment Logic

In this experiment, examinees will learn about celestial physics through two ways. One is the traditional teaching, and the other, VR-based teaching. In the traditional teaching, teachers perform his duty through narration and PPT in approximately 30 minutes, while in VR-based teaching, teachers utilize VR's celestial physics teaching application to teach also in 30 minutes. The two methods are adopted by the same teacher to avoid the experiment deviation caused by the professional difference among teachers.

The experiment will be carried out in two phases. The first phase is to prove the difference between VR-based teaching and traditional teaching in influencing students' academic performance and learning efficiency. The second phase is to prove the difference between VR-based teaching and traditional teaching in influencing students' long-term memory.

3.2-1 is the experiment procedure

3.2-1



3.3.Experiment Devices and Task.

Most of devices used in the experiment include the components for constructing the VR environment, like computers, head mounted display, interactive tracking system and some other components for testing. Here # 3.3-1 is the list.

3.3-1

Name	Brand/Model/Content	Quantity	Function
HMD & Interactive Tracking System	HTC VIVE	3	Display VR Contents
Traditional Teaching Plan	Course Materials for Celestial Physics (PPT)	1	Controlled Group
VR Celestial Teaching Application	Course Materials for VR Celestial Physics (Title: Universe Sandbox)	1	VR Group
Celestial Physics VR Teaching Guide	Celestial Physics VR Teaching Guide	1	VR Group

3.4.Experiment Measuring Method

This experiment integrates the objective measuring method and subjective measuring method. The objective measuring method uses objective problems to collect data, and the subjective method uses subjective problems to collect data and assess the result. Chart 3-4 is the information about the experiment measuring method.

3.4-1

Measuring Method	Measuring Content	Measuring method
Objective Measuring	Knowledge understanding	Measured through Objective measuring
Subjective Measuring	Students' attitude toward VR	Measured through Attitude Questionnaire

4. Objective Measuring Result

4.1.Immediate Test Average Score：

4.1-1

Sample	Gender	Level	Score	Re-examine-1
VRIT-A1	M	Grade A	90	
VRIT-A2	M	Grade A	100	
VRIT-A3	M	Grade A	100	
VRIT-A4	F	Grade A	100	
VRIT-B1	M	Grade B	75	100
VRIT-B2	M	Grade B	100	
VRIT-B3	F	Grade B	100	
VRIT-C1	M	Grade C	85	

VRIT-C2	F	Grade C	80	
VRIT-C3	F	Grade C	100	

Phase 1 VR Group Test Scores

4.1-2

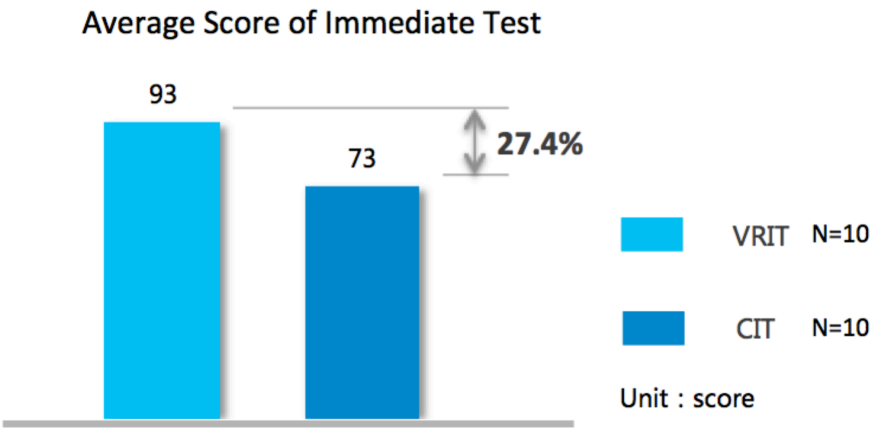
Sample	Gender	Level	Score	Re-examine-1	Re-examine2
CIT-A1	M	Grade A	100		
CIT-A2	M	Grade A	75	80	
CIT-A3	F	Grade A	70	85	
CIT-A4	M	Grade A	60	85	
CIT-B1	M	Grade B	100		
CIT-B2	F	Grade B	40	75	100
CIT-B3	F	Grade B	80		
CIT-C1	F	Grade C	85		
CIT-C2	M	Grade C	50	85	
CIT-C3	M	Grade C	70	85	

Phase 1 Controlled Group Test Scores

4.1.1. VR Improves Test Scores

The average score of the VRIT group is 93, CIT, 73. On average, VRIT group has registered a 27.4% growth in terms of score, indicating the great advantage of VR in the teaching of astrophysics.

4.1.1-1



As astrophysics is a science which students cannot really conduct experiments on in class, students can only try to understand it by their imagination and teachers' explanation. However, VR-based teaching makes it possible to present to students the abstract aerospace in a three-dimensional way, conduct simulated operations and let students experience the scenarios at different cosmic velocity. VR-based teaching is vivid and interactive. It helps students get better test scores by enhancing their ability of understanding and memorizing knowledge.

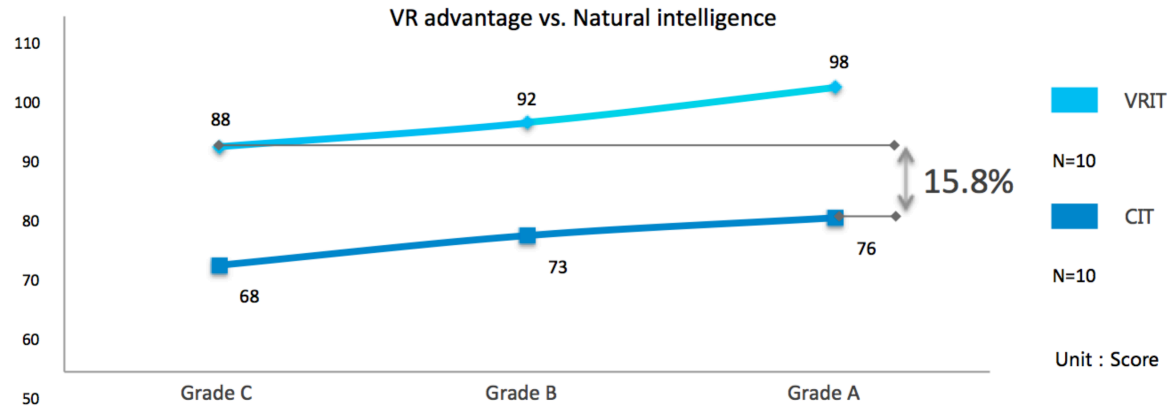
4.1.2. VR advantage vs. Natural intelligence

Students from each grade level achieved more progress by VR-based learning than traditional teaching; With the help of VR-based teaching, the average score of the grade level C group is better than Grade A level group who are taught by traditional teaching.

In the VR-based teaching group, the average score of Grade A, B, and C are respectively 98, 92 and 88, which are obviously higher that their counterparts taught by a traditional mode.

The average score of Grade C group reaches 88, 15.7% more than that of the Grade A group taught by traditional mode, suggesting that students who are at relative low score could possibly achieve high score with the help of VR-based teaching in some specific subjects. By trigger students' interest of learning, VR makes students more willing to learn. What's more, VR-based teaching could make students more attentive, more easily to absorb knowledge, and finally to improve their test scores.

4.1.2-1

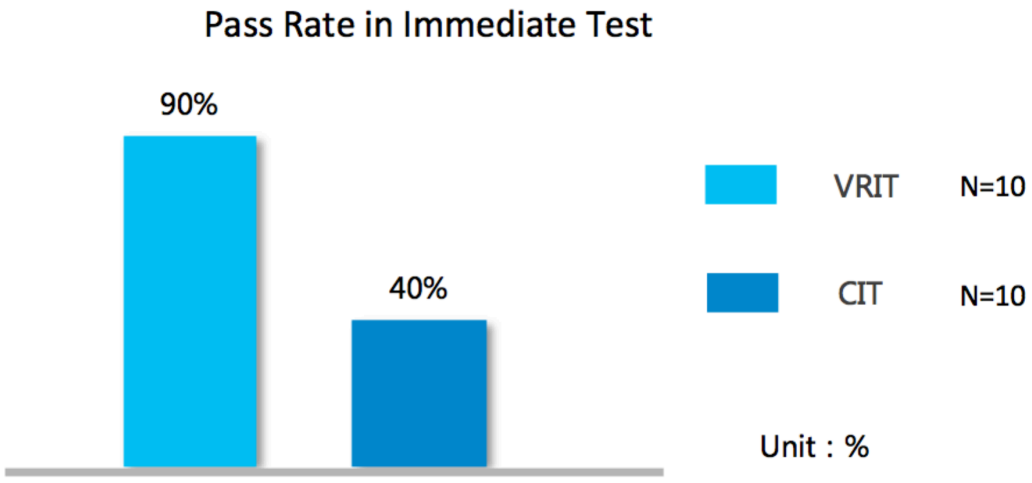


VR advantage vs. Natural intelligence

4.1.3. Immediate Test Pass Rate

The passing rate of VR group is 90%, while that of the traditional teaching group is 40%. The passing rate of VR group far exceeds that of the traditional teaching group, suggesting that VR-based teaching could make it easier for students to pass tests of certain subjects.

4.1.3-1

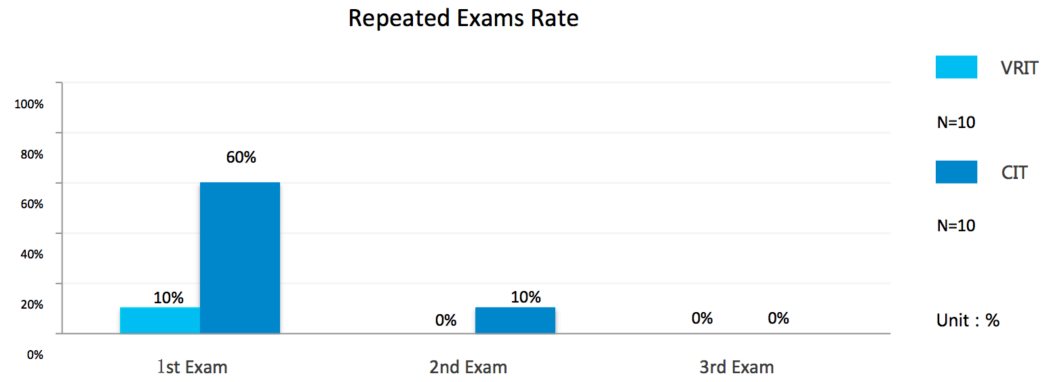


4.1.4. Repeated Exams

Only one student in VR group needs repeated teaching and test, accounting for 10% of the group members; In contrast, six students in traditional teaching group need

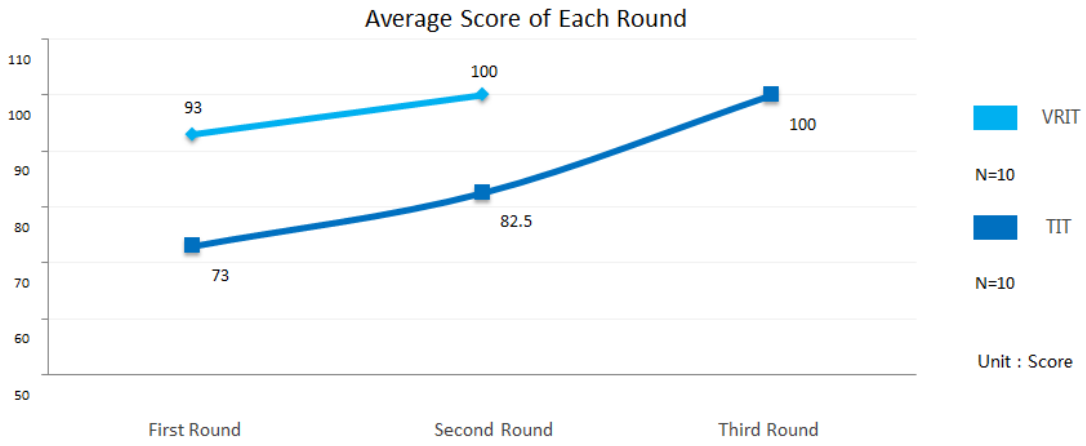
repeated teaching, accounting for 60% among the group members, and 5 of them passed the test after the second teaching. The other one passed the test after the third teaching. This suggests that VR-based teaching could improve students' learning efficiency. In this regard, VR-based teaching is not only conducive to students, but also to schools.

4.1.4-1



The average score of the VR-based teaching in the first test is 93, and the score of the student receiving repeated teaching is 100; The average score of the traditional teaching group is 73 in the first test. After the second teaching, the figure reaches 82.5. The student who has received a third teaching and test got 100 at last.

4.1.4-2



4.2.Retention Test Average Score

4.2-1

Sample	Gender	Level	Score
VRRT-A1	M	Grade A	100
VRRT-A2	M	Grade A	100
VRRT-A3	F	Grade A	95
VRRT-A4	M	Grade A	100
VRRT-B1	F	Grade B	85
VRRT-B2	M	Grade B	90
VRRT-B3	F	Grade B	75
VRRT-C1	M	Grade C	85
VRRT-C2	M	Grade C	90
VRRT-C3	F	Grade C	80

Phase 2 # VR Group Test Scores

4.2-2

Sample	Gender	Level	Score
CRT-A1	M	Grade A	90
CRT-A2	F	Grade A	75
CRT-A3	M	Grade A	45
CRT-A4	M	Grade A	80
CRT-B1	M	Grade B	70
CRT-B2	F	Grade B	75

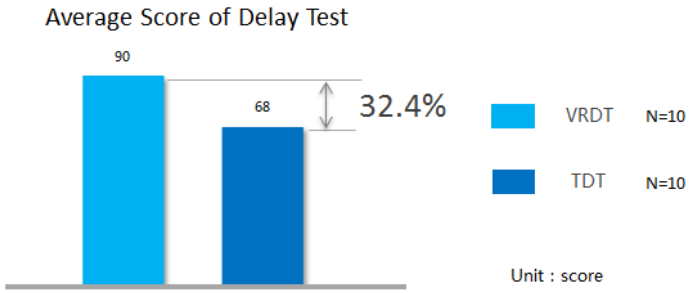
CRT-B3	M	Grade B	65
CRT-C1	F	Grade C	80
CRT-C2	M	Grade C	60
CRT-C3	女	Grade C	40

Phase 2 # Controlled Group Test Scores

4.2.1. VR Improves knowledge Retention

In Retention Test, the average score of VR group is 90, while that of the traditional teaching group is 68. The gap between the two average scores is 32.4%, higher than that in the Immediate Test 27.4% (# 4.1.1-1), suggesting that knowledge taught in traditional mode is more inclined to be forgotten, while VR-based teaching could help students get a deeper impression and maintain long-term memory because it creates a quosi-real environment, interacts with students and make students more involved in the teaching.

4.2.1-1



5. Subjective Measuring Result

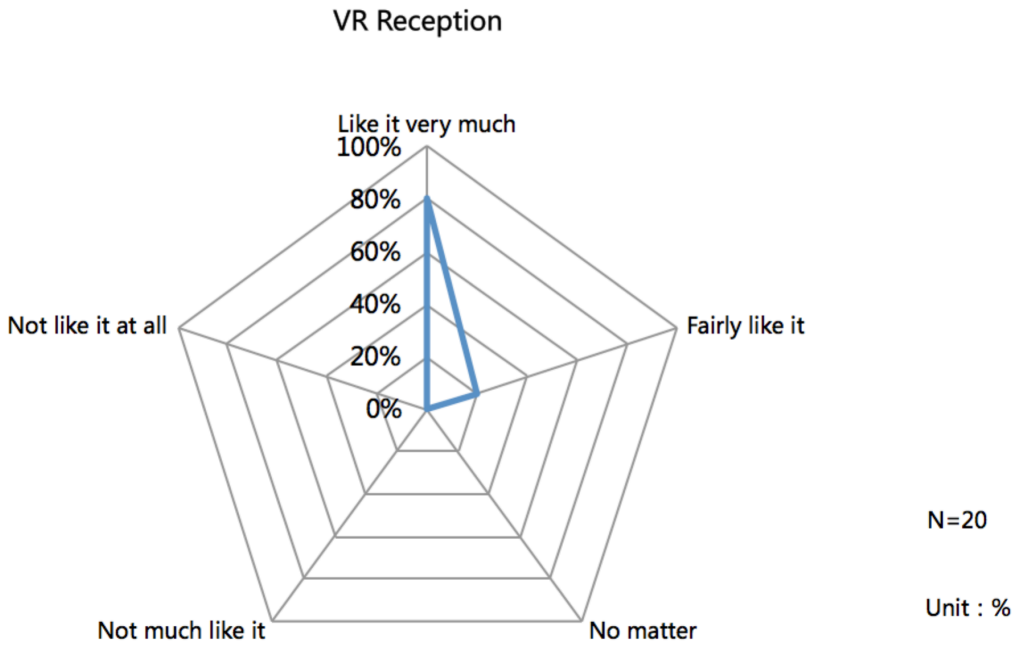
For your information: The two groups of 20 students received VR-based teaching filled out an attitude questionnaire.

5.1. VR Reception

VR-based teaching enjoys tremendously positive reception among students. Students like it very much and students fairly like it account for 100% of all the students. In the experiment, 65% students have heard about VR, 45% students have

experienced VR content, most of which is VR games. This is the first time for these students to experience VR in education. The introduction of the latest VR Technology into education is very fascinating to students, who are looking forward to seeing VR-based teaching integrated in their classes.

5.1-1



Students speak highly of the VR-based teaching in terms of the immersion, enjoyment, interactivity and high-tech.

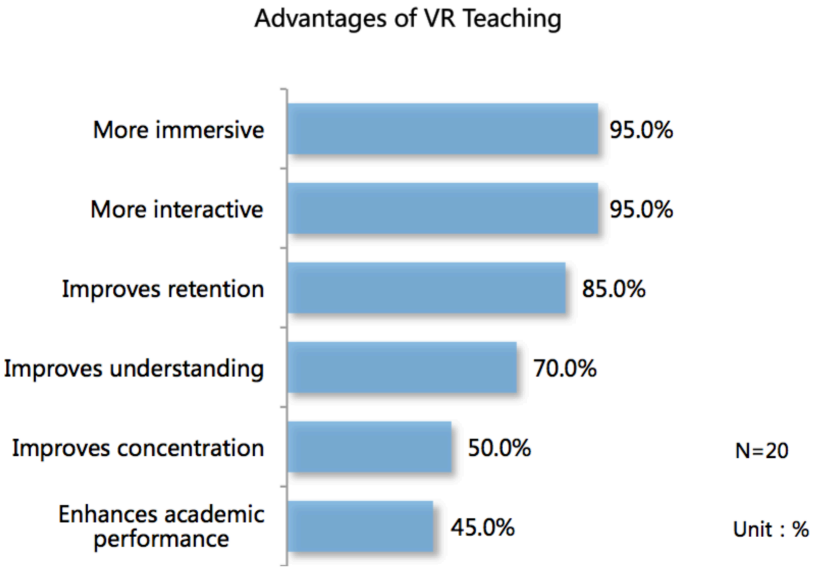
“Impressive!” exclaimed by a student who has never experience VR before. He said that “I can feel I am just in the middle of the universe. It’s so beautiful. I hope VR could be available in my school as soon as possible. I will be most interested in those most early VR-based subjects .”

5.2. Advantages of VR Teaching

VR enjoys obvious advantages in teaching, for example, it make the content of courses more vivid; students can experience by themselves; it is very interactive, and is easy to remember and understand.

A parent said: ”Traditional teaching plays a weak role in igniting students’ learning interest. However, VR-based teaching inspires students to learn and presents to students the abstract content occurred in the learning process in a vivid way, making it easier for students to understand and retain knowledge.

5.2-1

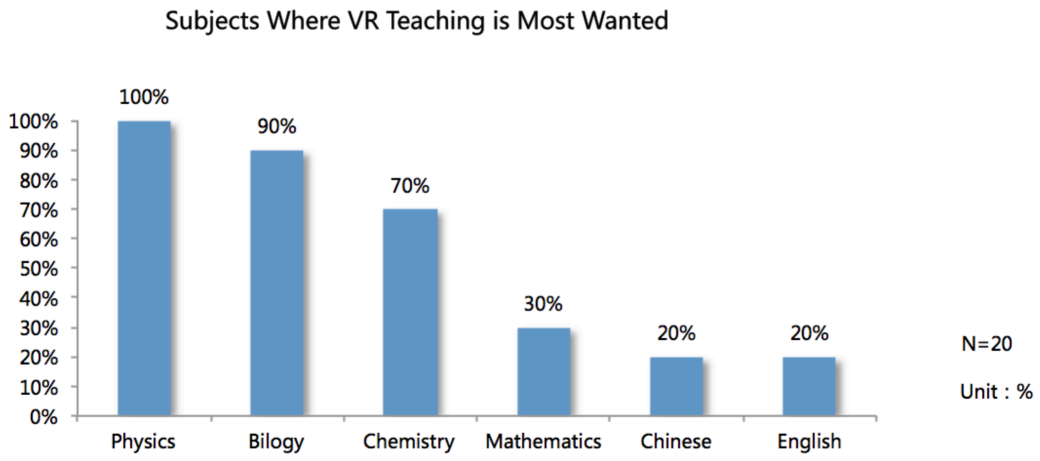


5.3. Subjects Where VR Teaching is Most Wanted

Currently, students hope that VR can be applied to physics, biology and chemistry. However, this might be a result of lack of VR education contents in other subjects at this moment.

Research shows that the immersive VR-based teaching is of great help to language learning. A China-based company CHOCENGLISH.com has already developed two VR apps. One is VR Class, and the other one is VR Foreign Language Partner. According to VR English teaching pioneers, VR is very suitable for English teaching, because for most people, English is a skill rather than a science. The acquisition of a skill lies in natural practice, not in the accumulation of knowledge. Students should learn the skill by simulating a vivid and natural environment like some of context that we developed where students can learn, observe and memorize in a natural and efficient way.

5.3-1

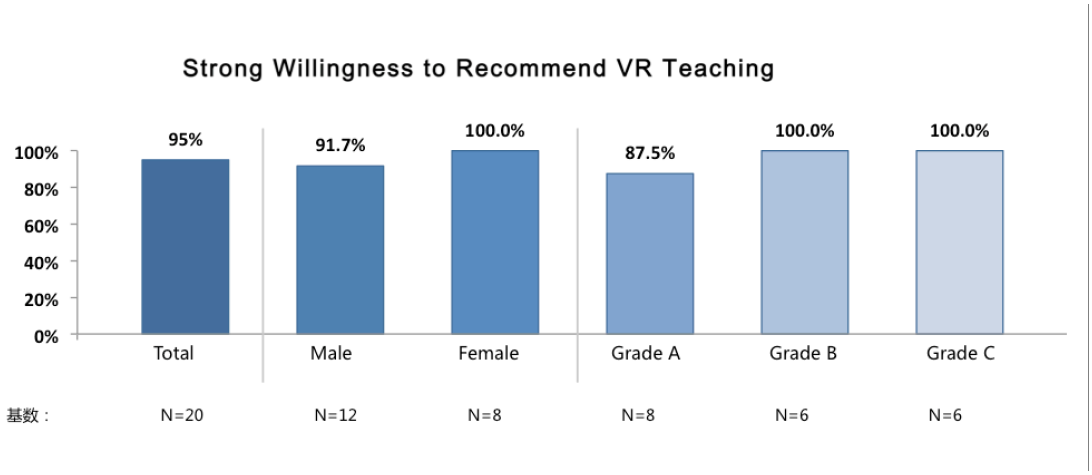


5.4. Willingness to Recommend VR Teaching

95% students are willing to recommend VR to others in their learning. Particularly, female students and the Grade B&C group members are more likely to recommend.

The reason is that female students are more initiative in learning, while male students are more inclined to play VR games; Grade B&C group members regard VR-base teaching a big help for them, thus willing to recommend.

5.4-1

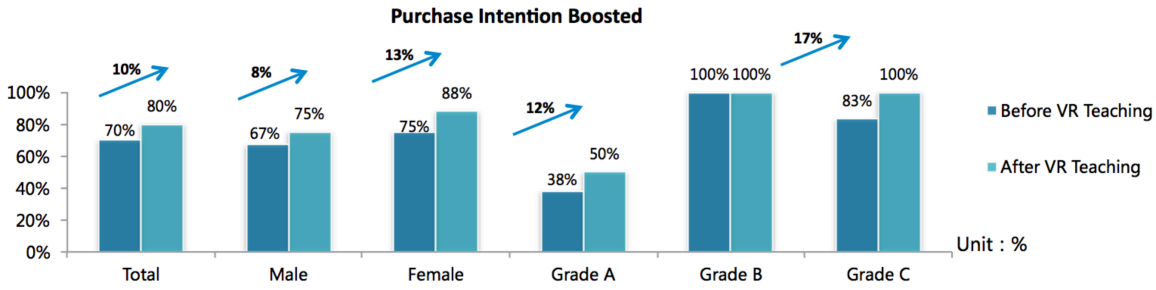


5.5. VR Purchase Intention

Before experiencing VR, students of purchasing intention take up 70% among all (price factor excluded). After experiencing VR, the figure reached 80%. The purchasing intention growth among female students and Grade C group students is even higher.

The reason is that female students are more likely to take initiative in learning, while male students are more inclined to play VR games; Grade C group students have a stronger wish to improve their test scores.

5.5-1



6. Conclusion

6.1. VR-based teaching improves students' test scores

The score of the VR group in the Immediate Test is 93, and the traditional teaching group, 73, representing a gap of 27.4% between the two groups. VR helps students improve academic performance in subjects like astrophysics.

6.2. VR-based teaching improves knowledge retention

In Retention Test, the average score of the VR group is 90, 32.4% more that of traditional teaching group which is 68. In Immediate Test, VR group is 27.4% more than traditional teaching group when it comes to the average test score. These figures indicate that knowledge is more inclined to be forgotten in traditional teaching, while VR-based teaching could help students retain knowledge.

6.3. No student is left behind. The right teaching method unlocks students' potentials

In our experiment, we made another interesting discovery. The average score of the Grade C students in VR group reached 88, 15.8% higher than that of the Grade A students in Controlled group. Every student has a special gift. As we found in the experiment, the right teaching method helps to discover children's unlimited potentials.

Besides astrophysics, VR-based teaching will be of great value in the teaching of subjects like chemistry and biology. Subjects whose contents cannot be easily visualized in real life are great areas for VR to play its magic. Things that are tiny and cannot be seen with bare eyes in real life, such as molecule, atomic structure, cells, the solar system and the galaxy can all be visualized in VR, transforming abstract and conceptual perceptions to concrete images and objects.

Every child is a genius in his or her own way. VR can be the key to awakening the genius inside.