Faculty of Education, Beijing Normal University

A Comparative Study on the Achievement of Teaching Objectives Based on Interactive AR Physical Simulation Experiment Program

Xiaojie NIU | Xueying XU | Lu CHENG（Undergraduates）
Su CAI（Associate professor, Tutor）

Background

Overview of Augmented Reality

Augmented Reality
(Vivid, real-time, high-resolution)

Real-time interaction

real world ⟷ **virtual world**

Background

Educational application of Augmented Reality

AR + Education improve the instructional effectiveness

especially significant in **physics**

abstract concepts
micro-knowledge
complex laws
important scientific inquiry methods

Background

Research results of VR/AR+ Education Lab

VR/AR + Education Lab

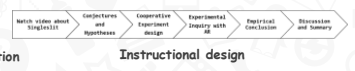
Positive impacts	Technical problems	Integration defects
knowledge learning emotional attitudes learning motivation	simple presentation modes shallow interactions difficult popularization	superficial integration of technology and teaching, illogical instructional design

Research Content

Our comparative study

Interactive AR application

Instructional design



"Knowledge-Process-Emotional Attitude" three-dimensional KAP model

Influences of interactive AR software on the achievement of KAP teaching objectives in inquiring learning

Research Process

Demand Analysis → Instructional Design → Program Development → Empirical Research

Research Process

Demand Analysis

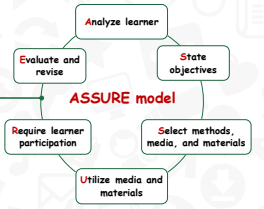
Demand Analysis | Instructional Design | Program Development | Empirical Research

- the current situation of the scientific inquiry ability of middle school students
- technologies and teaching models

Research Process

Instructional Design

Demand Analysis | Instructional Design | Program Development | Empirical Research

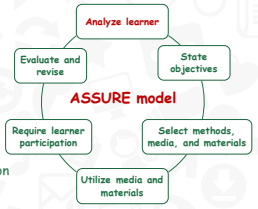


Research Process

Instructional Design

Demand Analysis | Instructional Design | Program Development | Empirical Research

- ✓ Break stereotyped thinking
- ✓ Abstract logical thinking ability
- ✓ Learning style: perceptual
- ✓ Visual learners
- ✓ Have never been exposed to any knowledge of single slit diffraction



Research Process

Instructional Design

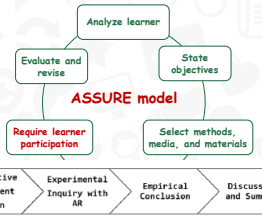
Demand Analysis | Instructional Design | Program Development | Empirical Research

	Internal state	External behavior
Learning objectives	have a good command of knowledge of single slit diffraction	Can repeat concepts relating to diffraction of light and its waviness correctly; Can describe the phenomenon of diffraction of light correctly.
	master experimental operations of single slit diffraction	Can describe the experimental process of single slit diffraction in detail correctly; Can conduct the experiment of single slit diffraction in person with cooperation of team members without any scientific error during each step.
	...	...
Expressive objectives	Can carry out effective communication with classmates and finish the experiment with classmates together; Can exchange with classmates about one's gain and feelings after the experiment	

Research Process

Instructional Design

Demand Analysis | Instructional Design | Program Development | Empirical Research



✓ learning activities:

Watch video about Singleslit → Conjectures and Hypotheses → Cooperative Experiment design → Experimental Inquiry with AR → Empirical Conclusion → Discussion and Summary

Research Process

Program Development

Demand Analysis | Instructional Design | Program Development | Empirical Research

- Development
- Testing
- Improvement

AR APP

+

WISE

Research Process
Program Development

- Place Recognition Figure (Light/Single Slit/Screen)
- Change the color
- Change the width of Slit
- Change the distance between screen and slit

(Use the Virtual buttons on the figures OR buttons below the screen)

Research Process
Instructional Design

Demand Analysis → Instructional Design → Program Development → **Empirical Research**

contrast experiment
random selection
controlled variable

- Class A: AR program independently developed by our research group.
- Class B: the animation in the virtual simulation environment.

Data Collection & Analysis
General statistics

Total Number	Valid	Recovered Number
70	68	70

A paired sample Z test for class A and class B on the pretest results

A significance of 0.473 > 0.05

Data Collection & Analysis
Knowledge Dimension

Descriptive Statistics of the Results of Knowledge Test

Subject	Basis		Extension	
Statistics	AVERAGE	Sd	AVERAGE	Sd
Class A	4.6	1.03	4.24	1.37
Class B	4.03	1.74	3.23	1.42

AVERAGE For Basis : A > B
For Extension : A > B

T-test
Sig = 0.025 < 0.05

Attention: We believe that no students have mastered this knowledge before the course is launched. Therefore, there is no pre-test for knowledge dimension, and the default is 0

Data Collection & Analysis
Process and Method

Data Analysis of Process Test-Estimated Marginal Means (ANCOVA)

Class	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
A	2.149[a]	.225	1.699	2.599
B	1.560[a]	.218	1.124	1.996

ANCOVA sig = 0.078 > 0.05
But the average : A > B

Data Collection & Analysis
Emotional Attitude

Descriptive Statistics of the Results of Process Test of Class A

	Pretest		Posttest	
Statistics	AVERAGE	Sd	AVERAGE	Sd
Cognitive	8.64	0.93	9.36	1.48
Emotional	11.42	1.51	12.33	1.54
Behavior	13.73	1.68	15.91	1.76

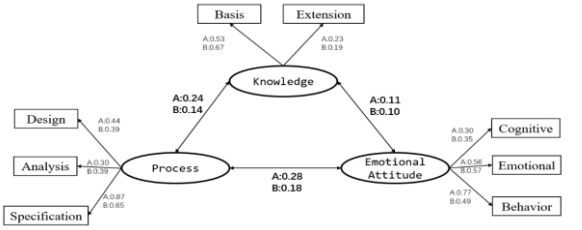
The Significant of pre and post test:

Cognitive(×) Emotional(×) Behavior(√)

A possible interpretation : Originally level is high

Data Collection & Analysis

Structural Equation ------ using SPSS and AMOS



Model	df	GFI	NFI	TLI	CFI	RMR	RMSEA
Fitting	65	0.812	0.803	0.957	0.909	0.043	0.043

Discussion & Summary

A video that shows the experiment

△ Teaching design corresponding to AR programs

Faculty of Education, Beijing Normal University

THANK YOU FOR LISTENING !!!

Xiaojie NIU | Xueying XU | Lu CHENG（Undergraduates）
Su CAI（Associate professor, Tutor）