



# VR in Education

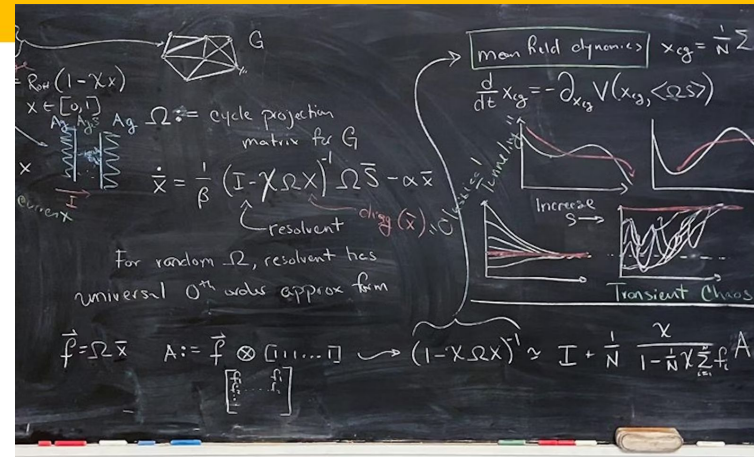
- What is holding you back? –

**Martin Skrodzki**

Teaching Academy  
Meet & Eat

27 February 2024





# Virtual Reality in Education – What is holding you back?

Martin Skrodzki, Computer Graphics and Visualization, INSY, EEMCS  
Delft University of Technology

# Who has ... used VR before?



# Who has ... access to a VR setup?



# Who has ... used/seen VR in education?





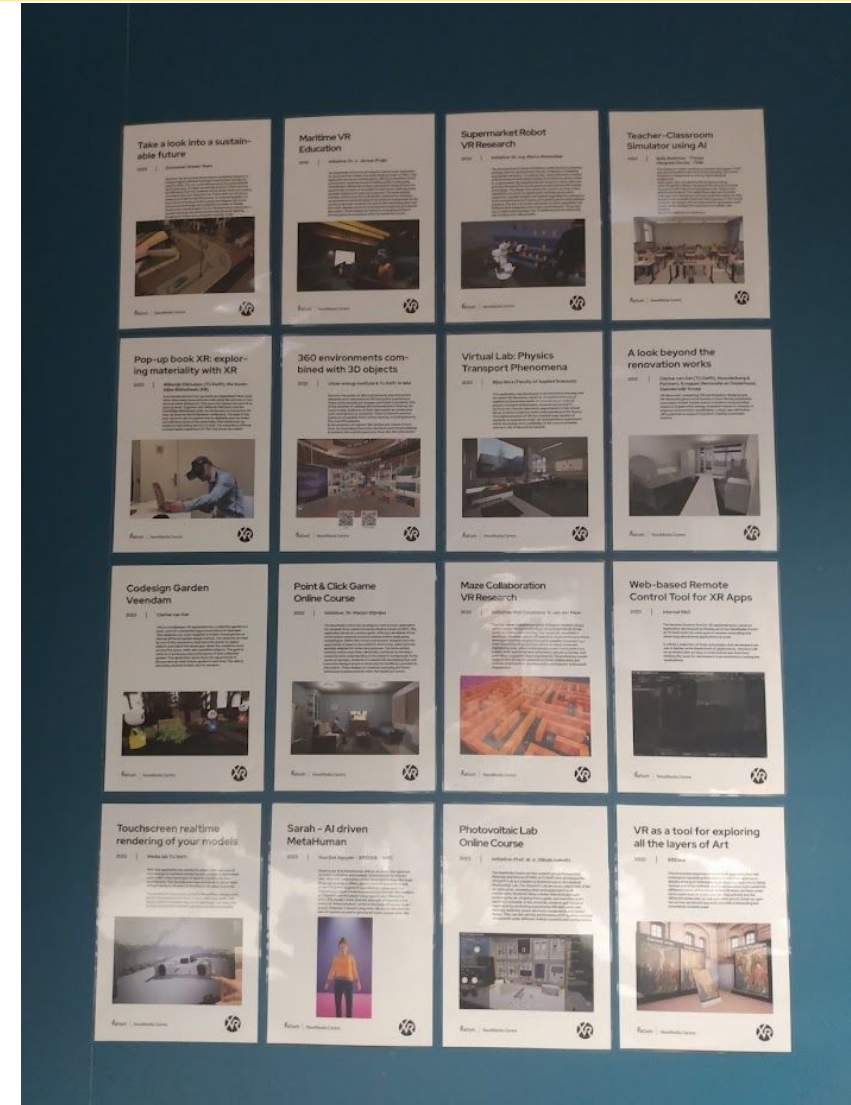
# Virtual Reality (VR)

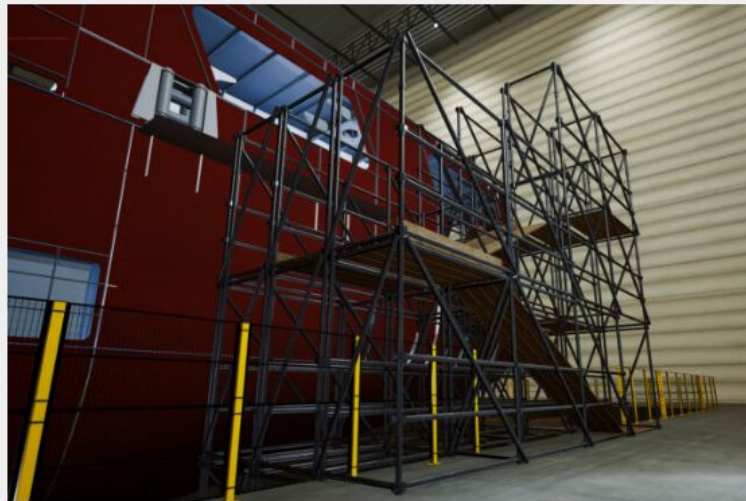


augmented reality

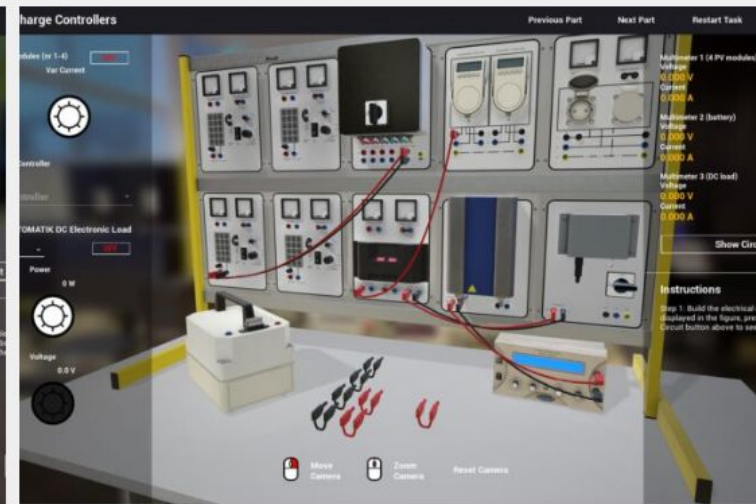
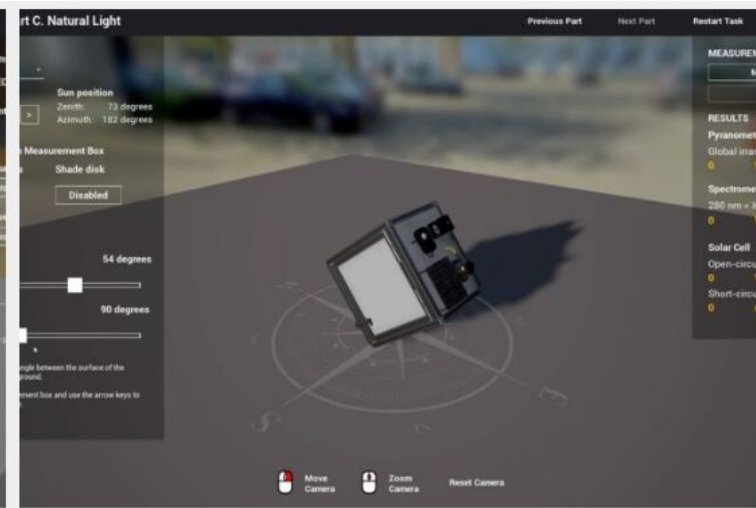
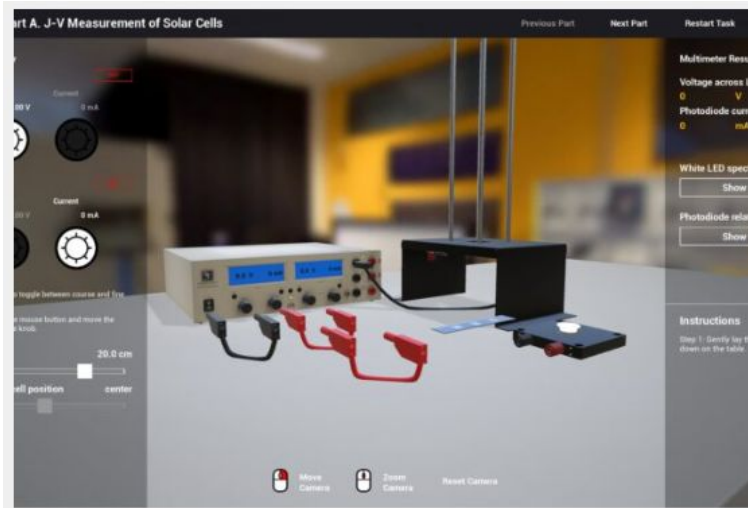


mixed/extended reality





<https://newmediacentre.tudelft.nl/vr-maritime/>



<https://newmediacentre.tudelft.nl/pv-lab/>

# What we Do



## XR Workstations

The XR Zone is equipped with more than ten state of the art workstations with all the required software installed. There are HTC Vive headsets and other VR tools for you to experiment with and a friendly dedicated staff to help you get started.



## XR Workshops

The XR Zone organizes workshops and classes for various XR topics: students, teachers and researchers from the TU Delft are welcome to learn modeling, animation and XR applications development.



## XR development

The XR Zone team is always happy to assist and advise you in exploring the use of XR in education or research. We can develop complete solutions or just assist and advise in existing or start-up projects.

# XR

## IN EDUCATION

SURF





# Why is VR not widespread?



## REVIEW article

Front. Virtual Real., 19 May 2023

Sec. Virtual Reality and Human Behaviour

Volume 4 - 2023 | <https://doi.org/10.3389/frvir.2023.1159905>

# Virtual reality and collaborative learning: a systematic literature review



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<https://www.frontiersin.org/articles/10.3389/frvir.2023.1159905/full>




# We design The Future

Project number: 2021-TR  
Duration: 01/09/2022


electronic, Didactive and Innovative Platform for Learning based On Multimedia Assets




# e-DIPLOMA




**TU Delft**  
Netherlands



**UPV**  
Spain



**Brainstorm**  
Spain



**BME**  
Hungary

WP1: Project Management				
The objective of WP1 is to ensure the efficiency of the project governance. It includes coordinating, monitoring and structuring of project activities.				
Number	Title	Lead	Dissemination Level	Release Date
WP1.1	Project Handbook (PH)	SLB	Sensitive	31 Oct 2022
WP1.2	Kick off and semi annual project meeting minutes	SLB	Sensitive	31 Aug 2023
WP1.3	Data Management Plan	CS	Public	25 Feb 2023
WP2: Current state on European context of learning and on creation of educational practices with emerging technologies				
It includes the learning ecosystem analysis, the study of remote e-learning in teacher training and the preparation of a toolbox of best practices.				
Number	Title	Lead	Dissemination Level	Release Date
WP2.1	Best practices report	TU Delft	Public	30 Jun 2023
WP2.2	Review of a learning ecosystem	TU Delft	Public	30 Sep 2023
WP2.3	Initial analysis/evaluation of the e-learning ecosystem for practice	TU Delft	Public	31 Aug 2023
WP2.4	Questionnaire for the framework	TU Delft	Public	31 Aug 2023
WP2.5	Development of a course	TU Delft	Public	31 Aug 2023
WP3: Writing and testing of didactic scenarios and technology enhancement				
The work package is aligned with the development of the prototype but focuses on the innovative use of emerging technologies in this context.				
Number	Title	Lead	Dissemination Level	Release Date
WP3.1	Guidelines and best practices extracted from training methodology	TU Delft	Public	31 Mar 2024
WP3.2	Validation and iteration dimensions implementing new techniques and traditional ones	TU Delft	Public	30 Sep 2024
WP3.3	Certification techniques demonstration in a e-DIPLOMA platform	SLB	Public	30 Sep 2024
WP3.4	AI Algorithms	SLB	Public	30 Sep 2024
WP3.5	Testing and Piloting Conclusion report	TU Delft	Public	31 Mar 2025
WP4: Development of learning modules and a Platform Deployment				
The required architecture will be designed and established for setting up the e-DIPLOMA platform.				
Number	Title	Lead	Dissemination Level	Release Date
WP4.1	Hardware technology specification	SMC	Public	31 Mar 2023
WP4.2	Software platform	SMC	Public	25 Feb 2024
WP4.3	Course prototypes	SMC	Public	30 Sep 2024
WP5: Assessment of the User Quality of Experience and Cognitive and Emotional Impact				
This work package will collect a detailed definition of the behavioral, psychophysiological educational and social metrics that will provide the most valuable data for the inclusion of skills in the platform.				
Number	Title	Lead	Dissemination Level	Release Date
WP5.1	Competency Specifications	UPV	Public	31 May 2024
WP5.2	Definition of appropriate metrics for the assessment of learning competencies	UPV	Public	31 May 2024
WP5.3	System usability and validation report and experience of individual measures	UPV	Public	31 Mar 2025
WP5.4	Specifications Report	UPV	Public	31 Mar 2025
WP5.5	Social and educational impact report	SLB	Public	30 Jun 2025
WP5.6	Readiness and training for teachers	SLB	Public	30 Jun 2025
WP6: Policy Recommendations				
The project focuses on creating and promoting policy recommendations, addressing local, national and European governments raised from a thorough analysis of the current situation in the field of e-learning.				
Number	Title	Lead	Dissemination Level	Release Date
WP6.1	Report of current policy situation and policy recommendations	SM	Public	25 Feb 2023
WP6.2	Report on the OECD	SM	Public	30 Apr 2023
WP6.3	Policy recommendation 2	SM	Public	31 Mar 2023
WP7: Data management, analysis, security, privacy, security, and regulatory aspects				
The main aim of WP7 is to develop a legal and ethical framework to provide guidance on addressing legal frameworks on software and tools development, communication of the outcomes, cybersecurity and data protection and establish sustainable governance for the data infrastructure.				
Number	Title	Lead	Dissemination Level	Release Date
WP7.1	Report on Mapping legal and Policy Considerations	CS	Public	26 Nov 2022
WP7.2	Privacy Plan	CS	Public	12 Nov 2022
WP7.3	Documentation Considerations Policy	CS	Public	29 Feb 2023
WP7.4	Report on ethics, accounting and overall legal compliance	CS	Public	31 Aug 2023
WP7.5	Ethical Documents for Check-Review	CS	Sensitive	31 Jan 2023
WP7.6	AI assessment and risk mitigation plan	SLB	Sensitive	30 Apr 2023
WP8: Dissemination, communication, and exploitation plan				
The main objective of this WP is the wide dissemination, communication and exploitation of the goals and results of e-DIPLOMA in all the actions involved, especially in the main areas of the educational process.				
Number	Title	Lead	Dissemination Level	Release Date
WP8.1	Dissemination, Exploitation and communication strategy	SLB	Sensitive	25 Feb 2023
WP8.2	Project website, logo and twitter network accounts	SLB	Public	31 Oct 2022
WP8.3	Periodic reports on Clustering, Dissemination and Communication	SLB	Sensitive	31 Aug 2023
WP8.4	Review the e-DIPLOMA	Brainstorm	Public	18 Feb 2023
WP8.5	Exploitation and other project communication plan	Brainstorm	Public	29 Feb 2023

<https://e-diplomaproject.eu/>



# Holonomy

## What is Holonomy?

- Holonomy is a Virtual Reality (VR) game in which a player attempts to navigate through a **hyperbolic space while staying within a 3x3 meter Euclidean space** [2].
- Figure 2 shows the game from the player's perspective. Around the left of the pillar, a river can be seen but around the right, the objective can be found. This difference is caused by the hyperbolic space.
- Players navigate this space with help from a minimap, shown in Figure 3.

## What is Hyperbolic Space?

- This **hyperbolic space** consists of **square rooms**.
- On the corners of each room, five square rooms come together.
- In this game, a **circle consists of 450 degrees**. To walk a circle, you must take five 90-degree turns around a pillar.
- The difference between the real world and the virtual space can be seen in Figure 1. Keep in mind that in both rows each turn is a 90-degree turn and each space is a square.
- You can see that from step 1 to step 3 (in Figure 1) the player walks a full circle in the virtual world while appearing to be one step further in the normal world. While walking a full circle in the virtual space you can also see that the player's orientation between the real and virtual space has changed by 90 degrees.

## Why a Virtual Reality Game?

- The holonomy team has been developing a game that allows players to navigate through rooms connected by hyperbolic geometry, see Figure 1.
- While **navigating an unknown** space can already be difficult, this difficulty only increases when the player finds themselves in a non-Euclidean space.
- Virtual reality (VR) is widely used to teach complex topics [1]. VR allows players to explore and understand the space. An additional benefit is that, because of the hyperbolic space in VR, a player can walk infinite distances in the virtual world while only staying within a 3mx3m room.

## References

- [1] Gan, W., Mok, T.-N., Chen, J., She, G., Zha, Z., Wang, H., Li, H., Li, J., and Zheng, X. (2023). *Researching the application of virtual reality in medical education: one-year follow-up of a randomized trial*. BMC Medical Education, 23(1).
- [2] Baran Yarar, Bo Bakker, Ravi Snellenberg, Riley Slotboom, Wenkai Li (2022). "Holonomy": a non-Euclidean labyrinth game in virtual reality. <http://resolver.tudelft.nl/uuid:6047910-f327-411e-a402-95d44e27f088>
- [3] Joris Rijdsdijk (2023). *Exploring the Impact of a Procedurally Generated Environment on Immersion in Virtual Hyperbolic Space*. <http://resolver.tudelft.nl/uuid:b2bcf835-240d-420e-b2f9-79aa433dbc21>
- [4] Scott Jochems (2023). *Mini-map positioning for Virtual Reality environments in hyperbolic space*. <http://resolver.tudelft.nl/uuid:9b3a815e-736e-4b09-9544-cb1ae6b78f70>
- [5] Ravi Snellenberg (2023). *Shortest Path algorithms for the traversal of an Order-5 square tiling within a confined space*. <http://resolver.tudelft.nl/uuid:b271f99b-8f8a-49b4-b1f8-5e6774a0f304>

Master Students: Scott Jochems, Joris Rijdsdijk, Ravi Snellenberg  
 Professors: Martin Skrodzki, Rafael Bidarra  
 Contact: m.skrodzki@tudelft.nl

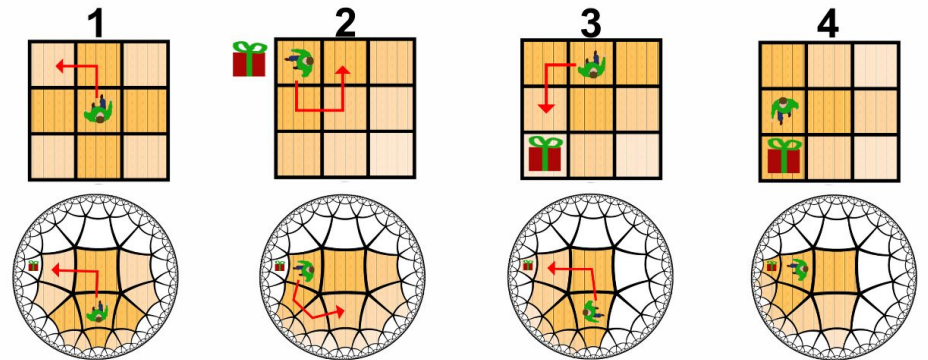


Figure 1: Real world (Top) vs hyperbolic movement in VR (Bottom)



Figure 2: An example of the visible 3x3 grid in the VR world

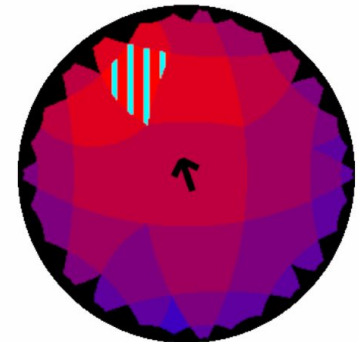


Figure 3: The minimap of holonomy. It uses a Hot-Cold colouring to help the player navigate toward the objectives. And the objectives are represented by striped squares.



## Quantum Physics vs. Classical Physics: Introducing the Basics with a Virtual Reality Game

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Rinke Schreuder, Amir Zaidi, Jan Willem David Alderliesten,  
and Rafael Bidarra<sup>(✉)</sup>

Faculty of Electrical Engineering, Mathematics and Computer Science,  
Delft University of Technology, Delft, The Netherlands  
R.Bidarra@tudelft.nl

**Abstract.** Unlike classical physics, quantum physics is harder to explain, as it involves very small scales and phenomena that are not visible to the naked eye. Understanding the differences between classical and quantum physics is difficult, especially for children, who cannot grasp the subtleties conveyed in complicated formulae.

We propose to achieve this in a playful and immersive manner, which is a more familiar and convenient way to introduce children to new concepts. For this we developed *Save Schrödinger's Cat*, a puzzle game in virtual reality featuring a classical physics mode and a quantum physics mode. As virtual objects and phenomena behave differently in each mode, this mechanic encourages players to toggle between modes, in order to explore the differences between quantum and classical physics in an immersive, entertaining and challenging way. A preliminary evaluation showed that players could better identify various distinguishing features of either mode.

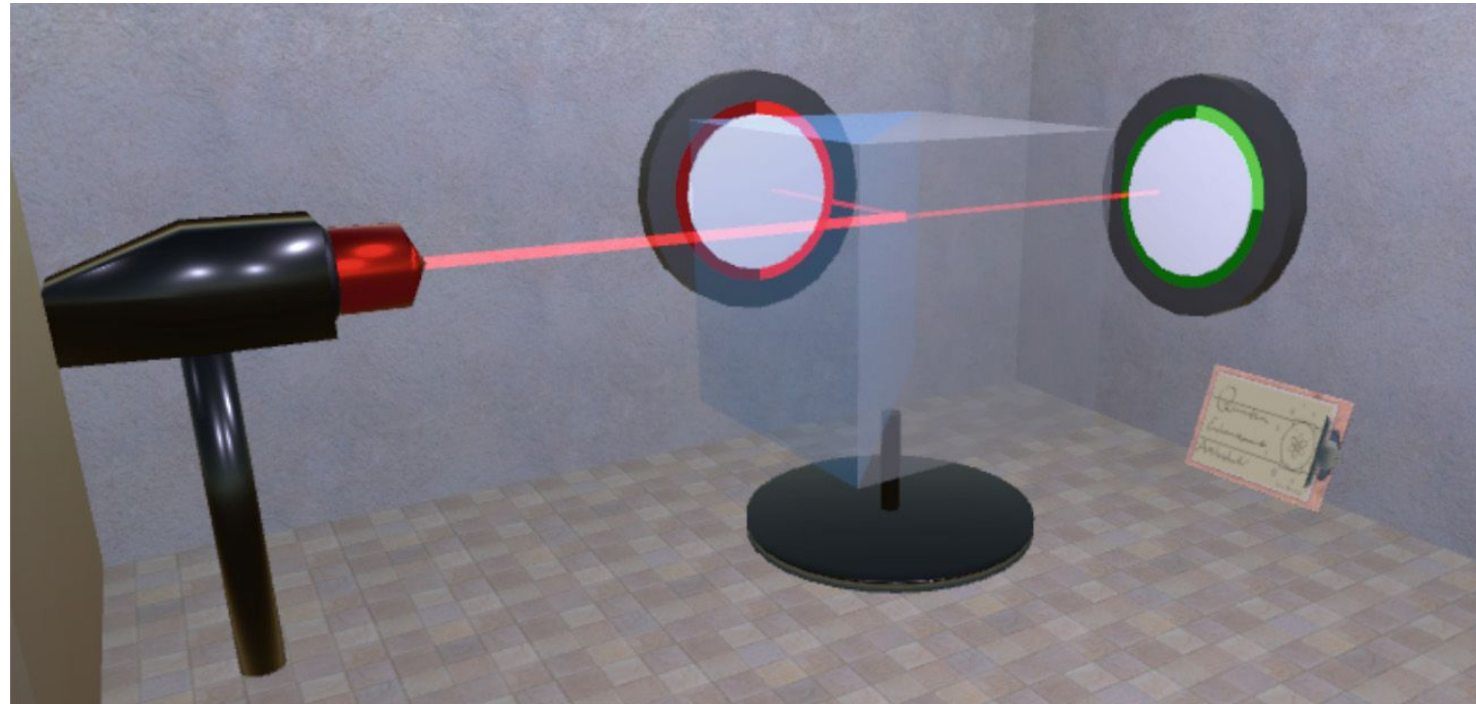
**Keywords:** Classical physics · Quantum physics · Virtual reality · Educational games

### 1 Introduction

Differences between quantum physics and classical physics can be hard to convey without referring explicitly to in-depth formalisms like formulas [6]. Quantum physics is important for understanding concepts of the universe that are not explicable with classical physics. However, quantum physics is generally considered to be difficult to understand, since this requires knowledge of the underlying theories and classical physics.

*How can one convey the differences between quantum physics and classical physics visually, without referring explicitly to in-depth formalisms like formulas?* Apart from some videos, there are currently no known accessible mediums that have accomplished this goal successfully for a large audience. Understanding

© Springer Nature Switzerland AG 2019  
A. Llapis et al. (Eds.): GALA 2019, LNCS 11899, pp. 383–393, 2019.  
[https://doi.org/10.1007/978-3-030-34350-7\\_37](https://doi.org/10.1007/978-3-030-34350-7_37)



<https://repository.tudelft.nl/islandora/object/uuid%3A793c3cf1-5506-43d1-90c3-feb12b0a41b0?collection=research>



# Are you interested to see how ...

- ... the obstacles that we identified can be overcome?
- ... VR can work in your educational setup?
- ... success metrics for VR in education can be defined?



Join me in starting a work group for VR in TU Delft education.

[m.skrodzki@tudelft.nl](mailto:m.skrodzki@tudelft.nl)



# Virtual Reality (VR)



# Focus on one thing at a time



Use images to illustrate your point



# Section headers

Subtitles with section headers

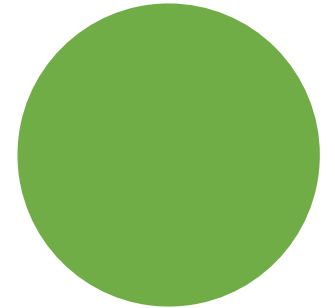
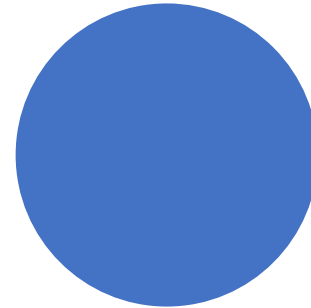
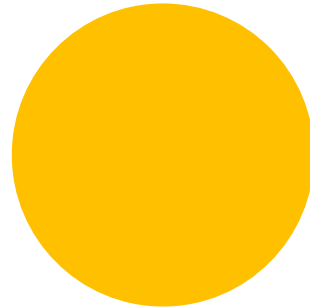
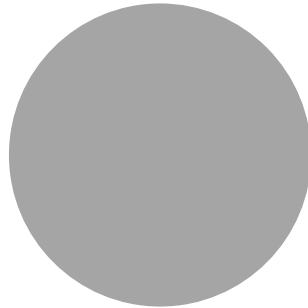
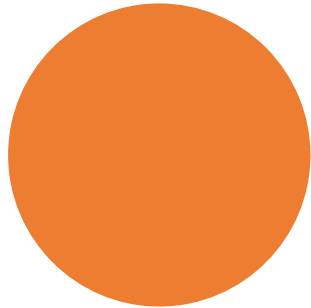
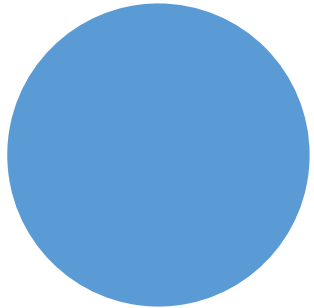


# Section headers

Subtitles with section headers

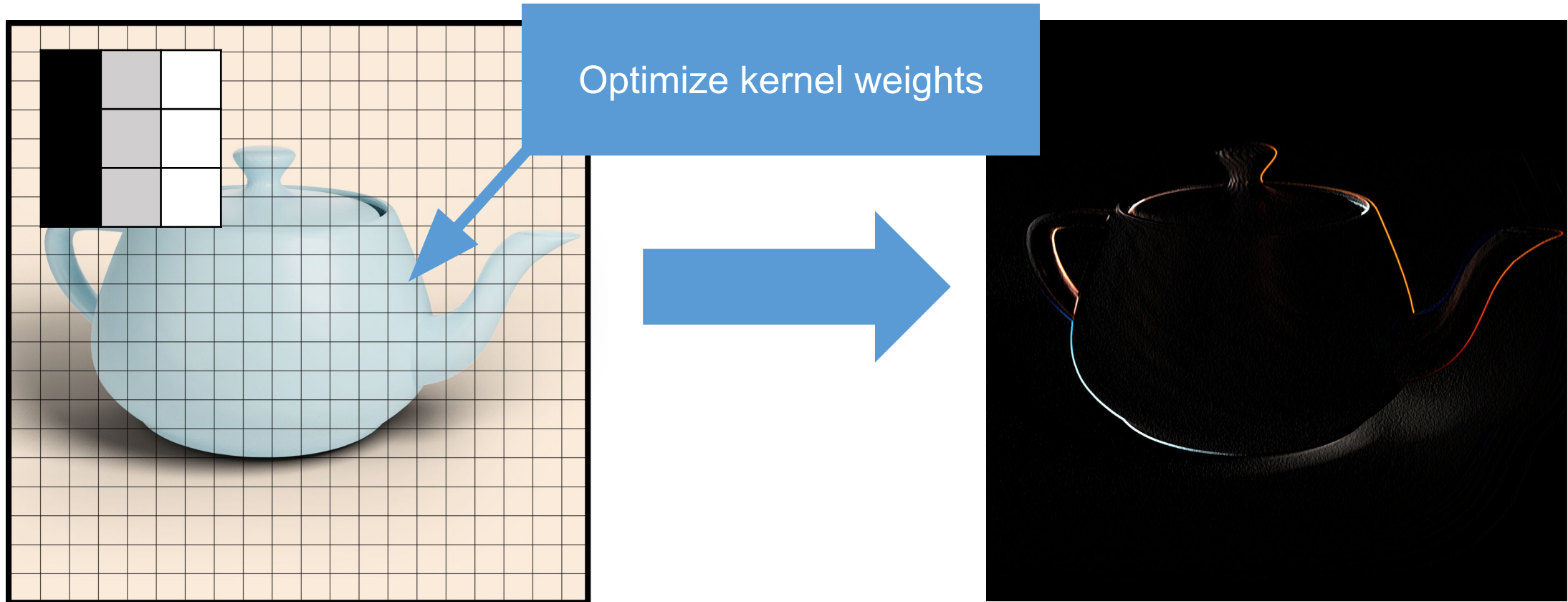


# Use colors from the TU Delft template





# Animations can guide focus





# Bulletpoints

- Don't default to bulletpoints
- People read them while you talk [1]
- Slides should support, not replace
  - Keep the bulletpoints in your notes
- If you **need** bulletpoints
  - Stick to the 7x7 rule: 7 points with 7 words max
  - Animate, so people don't read ahead



# This was the CGV Template

Author Firstname, First Lastname, Third Contributor

Delft University of Technology