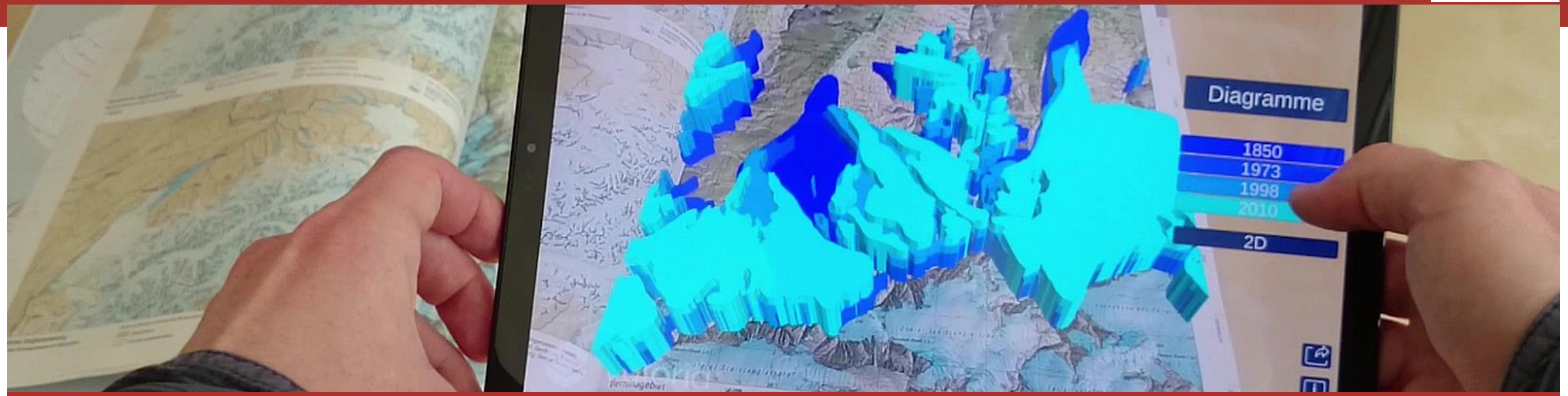
ETH zürich

IKG
Institute of Cartography and Geoinformation




# Augmenting Printed School Atlases with Thematic 3D Maps

Raimund Schnürer, Cédric Dind, Stefan Schalcher, Pascal Tschudi, Lorenz Hurni

EuroCarto 2020 presentation

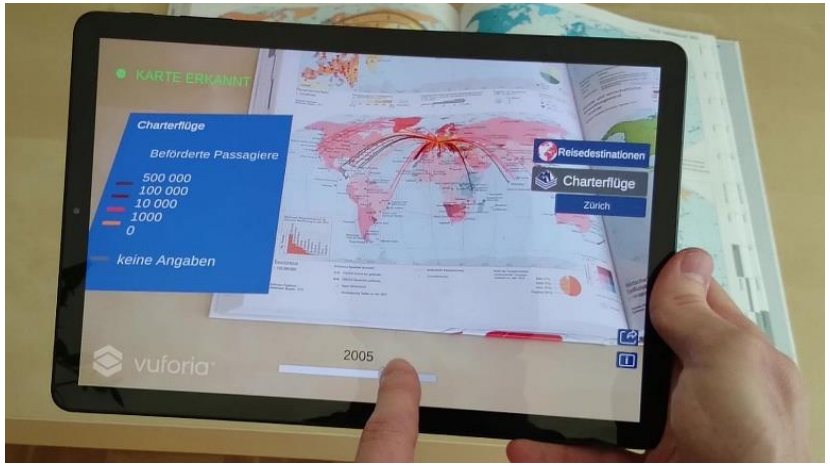
# Context in Switzerland

https://www.zg.ch/behoerden/gemeinden/menzingen/de/schulen/infos/lehrplan-21
https://www.freepik.com/free-photo/smiley-girl-posing-class_1193462.htm

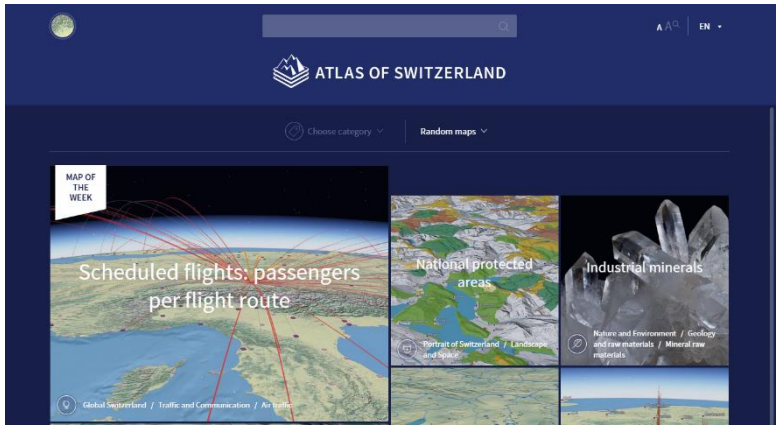
# Idea

Printed School Atlas

Mobile Device

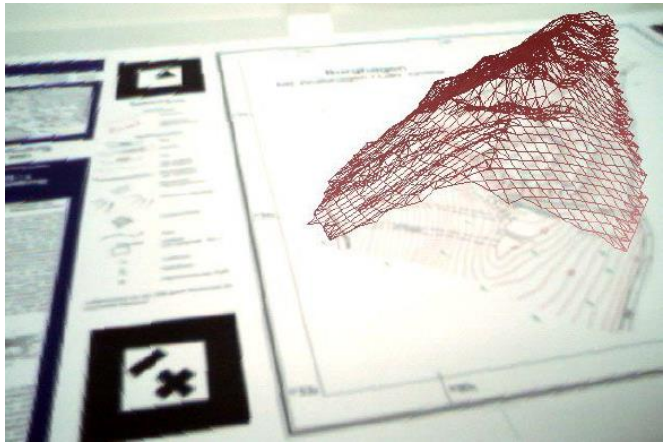



Augmented Reality Atlas




Digital National Atlas

# Related work



[Bobrich & Otto 2002]

[Bergig et al. 2011]

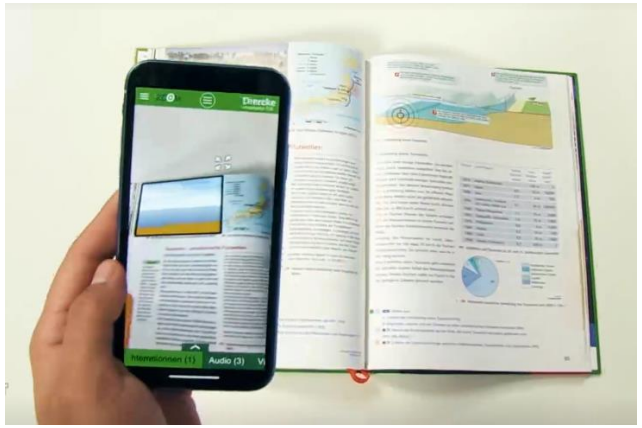
[Eggert et al. 2014]

marker-based approaches with codes

hybrid approaches

marker-based approaches with natural features

# Related work



Zoom App
[Westermann-Gruppe 2015]

Livemap Switzerland
[Wüest & Nebiker 2017]

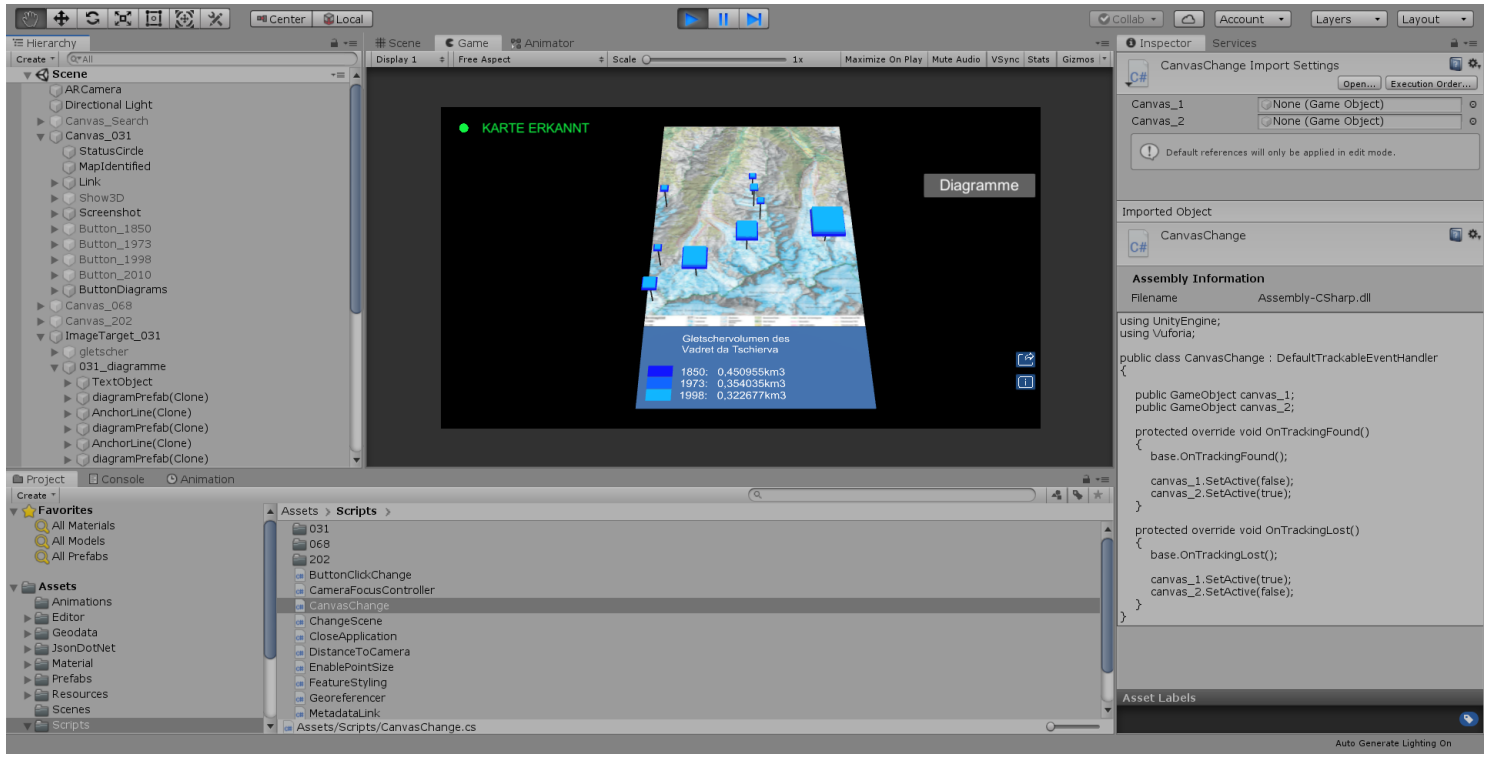
Bulgarian School Atlas
[Yonov 2019]

Previous applications concentrated on topographic 3D elements and multimedia content.

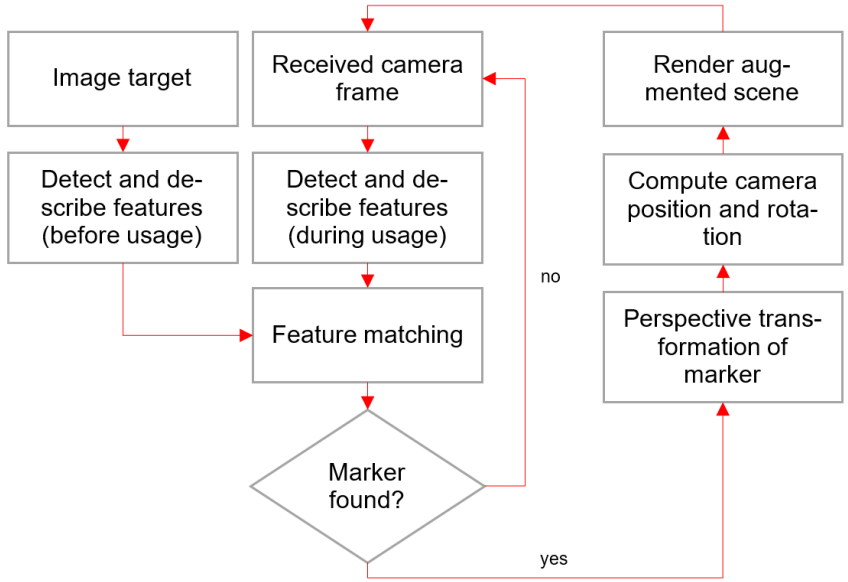
↓

We focus on augmenting maps with thematic 3D elements.

# Implementation: Recognition




Unity with Vuforia Engine




Recognition workflow

# Implementation: Import of geodata

1st attempt

Shapefile
↓
Blender (with BlenderGIS add-on)
↓
FBX
↓
Unity

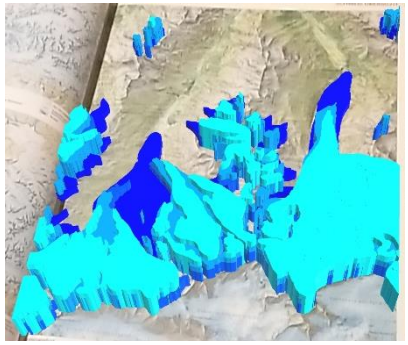
scaling and offset error

2nd attempt

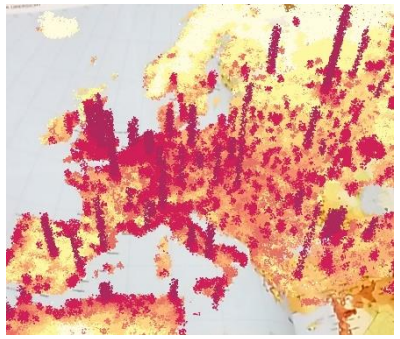
GeoJSON
↓
GeoJSON.Net library
↓
Unity

everything ok

# Implementation: 3D visualizations

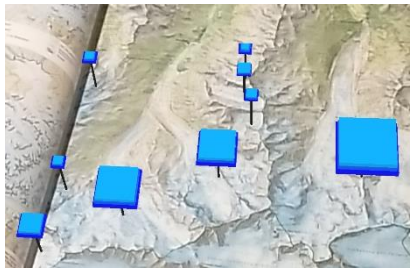


`Meshes`[1,2] with offset for extruded polygons



`Meshes` with custom shader for point cloud

`Cube`[1,2] for 3D bars



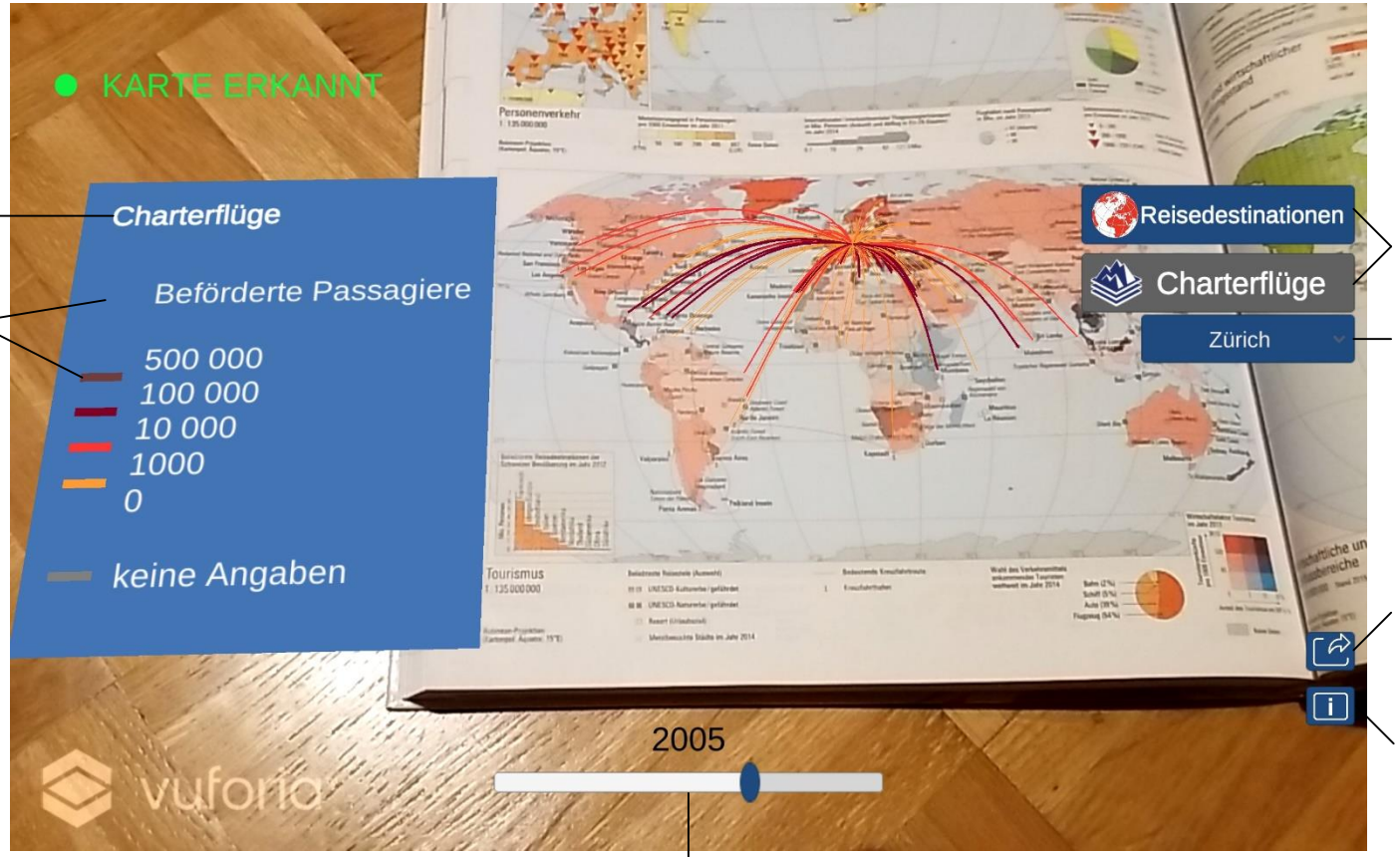
`Cube`[2] for stacked cuboids

`Rotated images`[2] for pie charts, `Cylinders` for anchors

`LineRenderer` for curved lines

1 `Animator` for extrusion animation
2 `Camera.ScreenPointToRay + Physics.Raycast` for feature query

# Implementation: User interface




Text Mesh

Planes

Buttons

Dropdown

ScreenCapture.
CaptureScreenshot

Application.OpenURL

Slider

KARTE ERKANNT
Elektrizität:
Endverbrauch
Verbrauchergruppe
Industrie
Verkehr
Haushalt
Dienstleistu
Verbrauch [Mia. kWh]
Sektor
Industrie
Verkehr
Haushalt
Landwirtschaft
Dienstleistungen
Bevölkerungsdichte
Energieverbrauch
vuforia

# Evaluation: Setting

Our stand at a Geomatics exhibition

Participants:

- 56 students from secondary schools
- Average age: 15.6 years
- 37 male, 19 female, 0 diverse

Materials:

- 2x3 printed atlas maps
- 2 tablets (for AR)
- 2 smartphones (for survey)

# Evaluation: Hypotheses

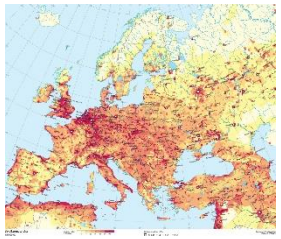
**H1:** Spatial literacy will be improved by AR.

**H2:** The interest to study a geographic topic will be more encouraged by AR.

**H3:** Sustainable norms and values will be better conveyed by AR.

# Evaluation: Procedure

or



or

Map

Spatial literacy (H1):
Assessment task &
Reflection question

Part I

Thematic interest (H2):
Assessment task &
Reflection question

or

Sustainable norms (H3):
Assessment task &
Reflection question

Part II

Part I: Printed map
Part II: Augmented map

or

Part I: Augmented map
Part II: Printed map

Order

# Evaluation: Part I example

Augmented map:
Population density

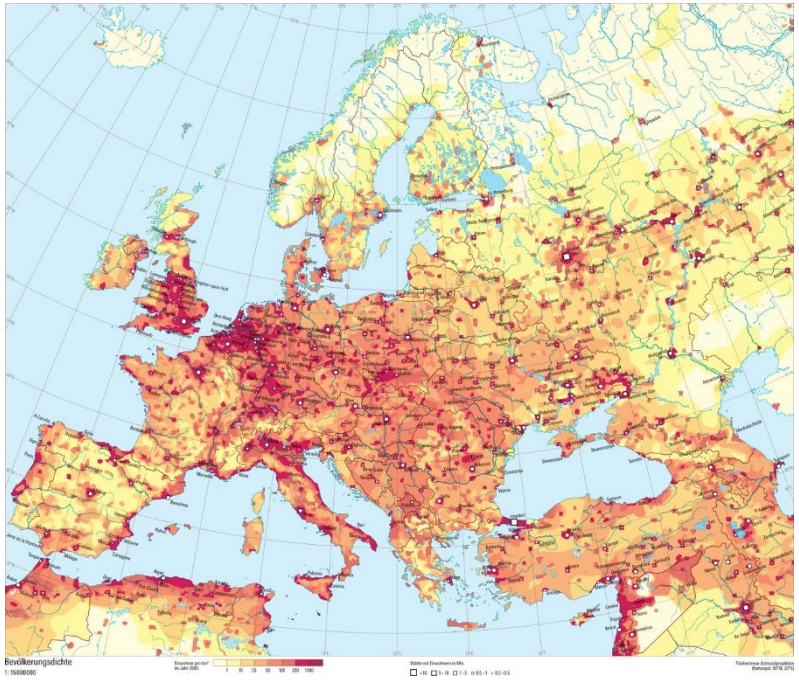
## Spatial literacy (H1) assessment task

State a sparsely and a densely populated area in Europe:
(a) South of Poland and Iceland
(b) England and Po valley
(c) Lapland und the Pyrenees

## Spatial literacy (H1) reflection question

How easy or difficult was it to spatially orientate yourself?
(a) very easy
(b) easy
(c) moderately difficult
(d) difficult
(e) very difficult

# Evaluation: Part II example



Printed map:
Population density

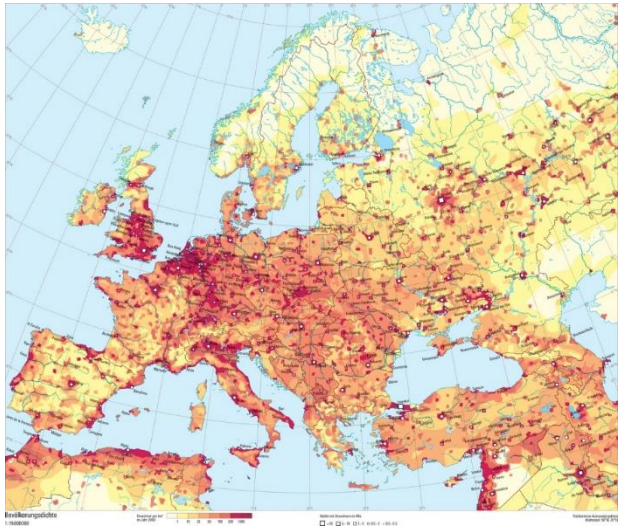
## Thematic interest (H2) assessment task

Explain the difference in peopling of Scandinavia compared to Central Europe:
(a) high emigration number
(b) small birth rate
(c) late industrialization

## Thematic interest (H2) reflection question

How interesting or boring was the previously elaborated topic to you?
(a) very interesting
(b) interesting
(c) moderately interesting
(d) boring
(e) very boring

# Evaluation: Part II example



Printed map:
Population density

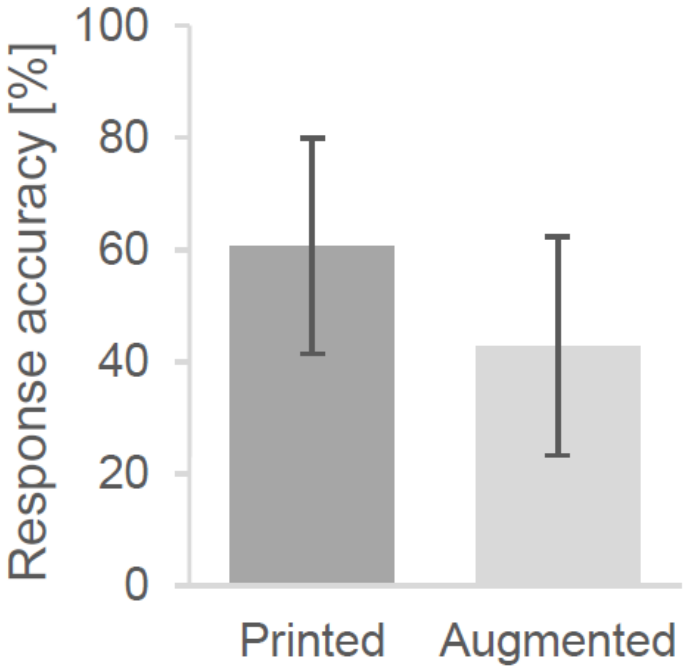
## Sustainable values (H3) assessment task

Judge the following statement by Johansson, the Swedish minister on integration by means of the population density map "One can also seek asylum in Germany or Denmark. Europe is larger than Sweden":
(a) I agree to the statement according to the population density distribution in Europe.
(b) In my opinion, the number of inhabitants of a country should not be the only decisive factor for the distribution of asylum seekers.
(c) Sweden should grant asylum to more people since the country is sparsely populated.

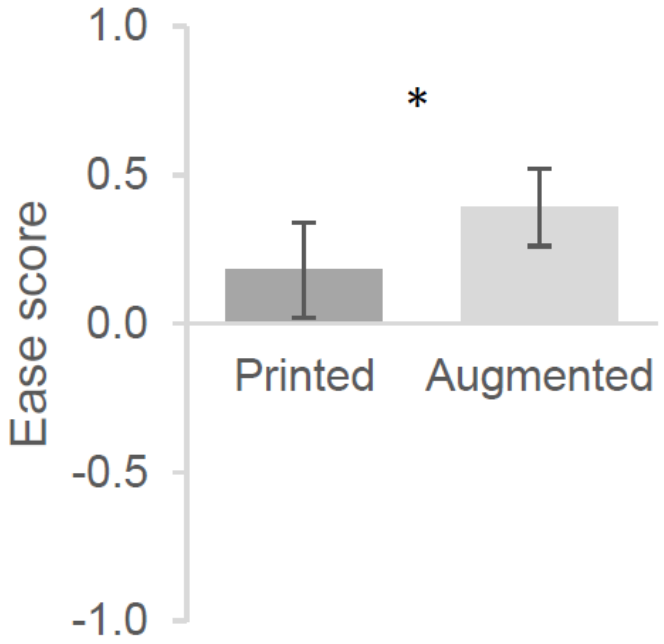
## Sustainable values (H3) reflection question

How did your opinion change while working with the map?
(a) much less sustainable
(b) less sustainable
(c) equally sustainable
(d) more sustainable
(e) much more sustainable

# Evaluation: Spatial literacy (H1)



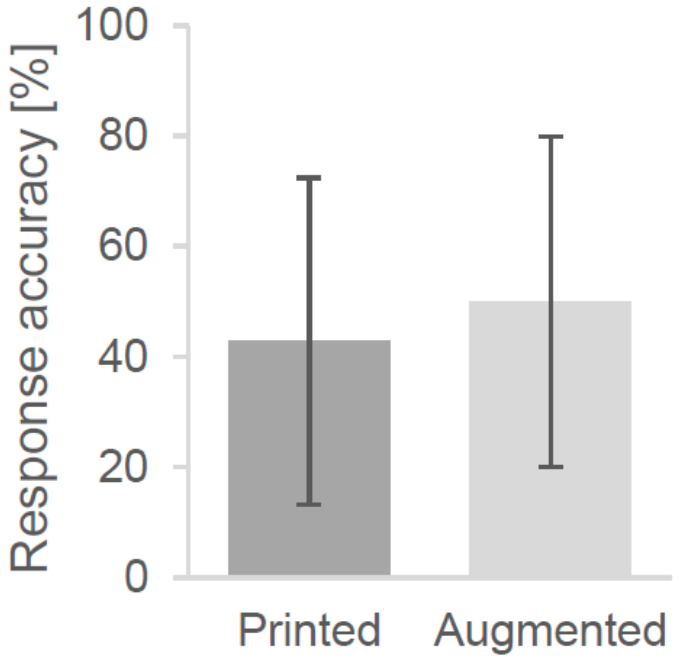

Effectiveness of map analysis



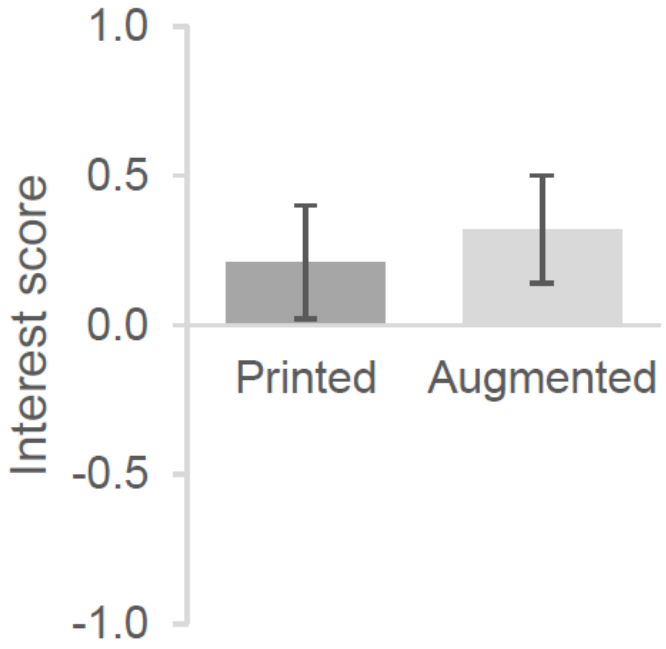

Ease of spatial orientation

N = 2 x 28

# Evaluation: Thematic interest (H2)



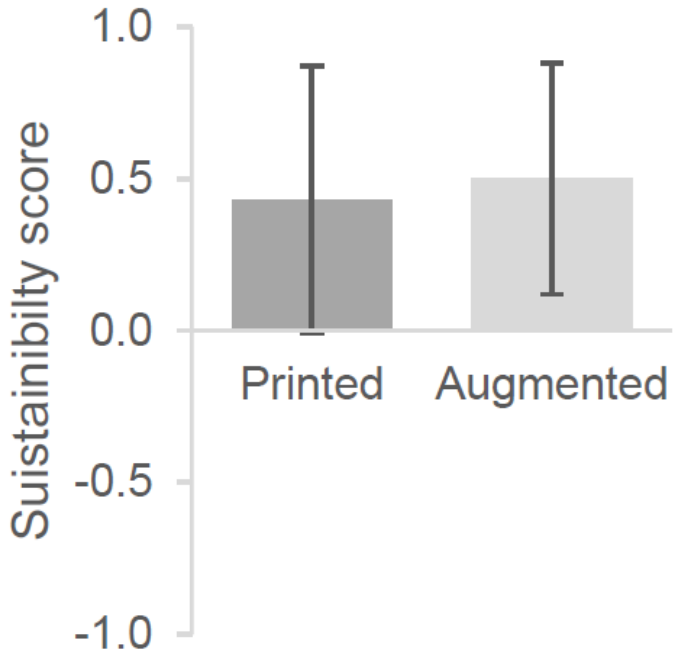

Effectiveness of map interpretation



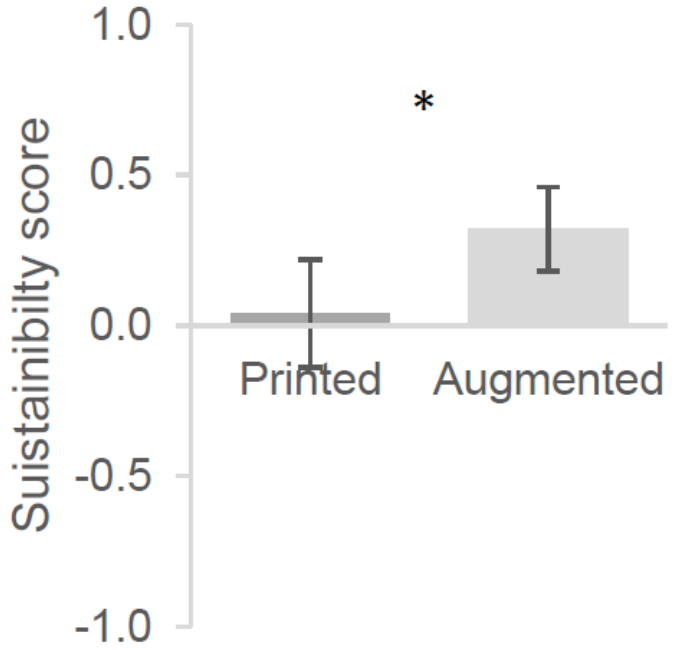

Interest in map topic

N = 2 x 14

# Evaluation: Sustainable norms (H3)




Attitude from map judgement




Change of attitude

N = 2 x 14

# Summary

- We succeeded in implementing a functional prototype.
- The results of all assessment tasks (i.e. analysis, interpretation, judgement) and students‘ interest in geographic topics did not differ significantly between printed and augmented maps.
- Students indicated that they could spatially orientate themselves easier with AR and they felt that their attitude was influenced in a more sustainable way.

➢ All hypotheses have to be rejected, though there is a positive trend towards AR.

# Challenges

| Problem | Possible solution |
|---|---|
| Bent printed atlas sheets | Apply a folded surface model [Martedi 2011] |
| Limited device storage | Download geodata from a server |
| Manual upload of image targets to detect natural markers | Place an order for this feature,<br>Swap to another software |
| Legend placement | Within the user interface,<br>By reference frames [Bleisch 2011] |
| Fatigueness of users | Assign only short tasks |
| Jittering of digital objects at steep angles | Improve accuracy by Convolutional Neural Networks [Akgul et al. 2016] |

# Future work

- Content presentation
- Coherent design
- Cartographic refinements
- Advanced functionality
- Apply didactical concepts
- Different usability experiments
- Other operating systems

# Thank you for your attention!

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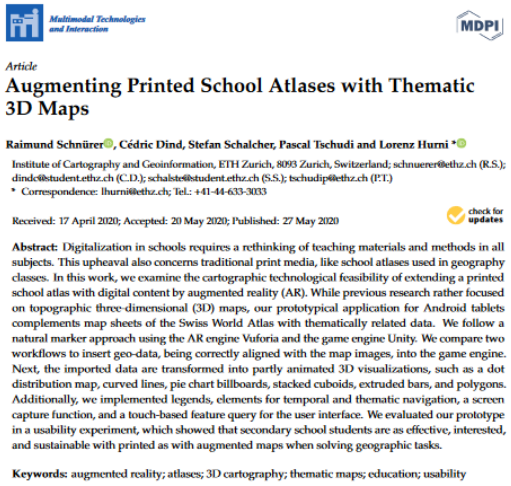

Multimodal Technologies and Interaction — MDPI

*Article*

**Augmenting Printed School Atlases with Thematic 3D Maps**

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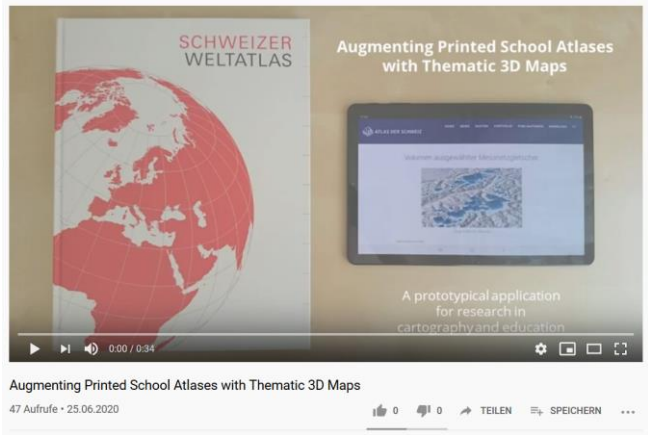
**Abstract:** Digitalization in schools requires a rethinking of teaching materials and methods in all subjects. This upheaval also concerns traditional print media, like school atlases used in geography classes. In this work, we examine the cartographic technological feasibility of extending a printed school atlas with digital content by augmented reality (AR). While previous research rather focused on topographic three-dimensional (3D) maps, our prototypical application for Android tablets complements map sheets of the Swiss World Atlas with thematically related data. We follow a natural marker approach using the AR engine Vuforia and the game engine Unity. We compare two workflows to insert geo-data, being correctly aligned with the map images, into the game engine. Next, the imported data are transformed into partly animated 3D visualizations, such as a dot distribution map, curved lines, pie chart billboards, stacked cuboids, extruded bars, and polygons. Additionally, we implemented legends, elements for temporal and thematic navigation, a screen capture function, and a touch-based feature query for the user interface. We evaluated our prototype in a usability experiment, which showed that secondary school students are as effective, interested, and sustainable with printed as with augmented maps when solving geographic tasks.

**Keywords:** augmented reality; atlases; 3D cartography; thematic maps; education; usability

https://doi.org/10.3390/mti4020023

Source code: closed
Usability data: open




https://youtu.be/o8xh_UxynVo

Upcoming presentations
4:35pm: René Sieber “Current challenges in Atlas Cartography”
6:40pm: Pascal Tschudi “Neue Aufgabenkultur für digitale Kartenarbeit im Schulunterricht mittels mobiler Geräte“

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