

A Value-Added Study: Investigating the Effects of Drawing and Explaining as Generative Learning Strategies when Learning in VR

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The Immersion Principle in Multimedia Learning

Theory

Method

Results

Discussion

- Immersive Virtual Reality (VR): simulated 3-dimensional, interactive environments (Sherman & Craig, 2018)
- Highly immersive media is more effective for learning (Makransky, 2021)
- Can be further enhanced
 - Multisensory stimuli (Spangenberg et al., 2022)
 - Generative learning activities (Parong & Mayer, 2018)

Makransky, G. (2021). The Immersion Principle in Multimedia Learning. In R. E. Mayer & L. Fiorella (Eds.), *The Cambridge handbook of multimedia learning* (3rd ed., pp. 296-302). Cambridge University Press.

Parong, J., & Mayer, R. E. (2018). Learning science in immersive virtual reality. *Journal of Educational Psychology, 110*(6), 785-797.
<https://doi.org/10.1037/edu0000241>

Sherman, W. R., & Craig, A. B. (2018). *Understanding virtual reality: Interface, application, and design*. Morgan Kaufmann.

Spangenberg, P., Geiger, S. M., & Freytag, S.-C. (2022). Becoming nature: Effects of embodying a tree in immersive virtual reality on nature relatedness. *Scientific Reports, 12*(1), Article 1. <https://doi.org/10.1038/s41598-022-05184-0>



Generative Learning Activities

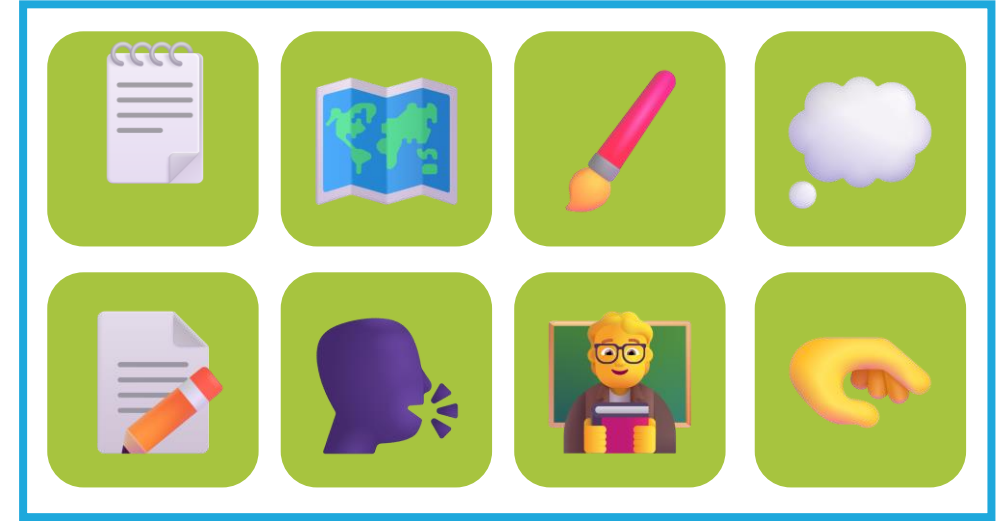
Theory

Method

Results

Discussion

- Eight activities that promote generative learning (Fiorella & Mayer, 2016)
- Summarizing and Teaching can be effectively added to VR (Klingenberg et al., 2020; Petersen et al., 2023)
 - Unclear for other activities (i.e. Drawing, Self-Explaining)
 - Focused mainly on cognitive learning objectives



Fiorella, L., & Mayer, R. E. (2016). Eight Ways to Promote Generative Learning. *Educational Psychology Review*, 28(4), 717-741.

<https://doi.org/10.1007/s10648-015-9348-9>

Klingenberg, S., Jørgensen, M. L. M., Dandanell, G., Skriver, K., Mottelson, A., & Makransky, G. (2020). Investigating the effect of teaching as a generative learning strategy when learning through desktop and immersive VR: A media and methods experiment. *British Journal of Educational Technology*, 51(6), 2115-2138.

<https://doi.org/10.1111/bjet.13029>

Petersen, G. B., Stenberdt, V., Mayer, R. E., & Makransky, G. (2023). Collaborative generative learning activities in immersive virtual reality increase learning.

Computers & Education, 207, 104931. <https://doi.org/10.1016/j.compedu.2023.104931>



Cognitive and Affective Learning Outcomes in VR

Theory

Method

Results

Discussion

- Cognitive
 - Transfer, retention (Klingenberg et al., 2020)
 - Cognitive load, knowledge (Petersen et al., 2023)
- Affective
 - Motivation, enjoyment (Klingenberg et al., 2020)
 - Positive emotions (Yang & Wang, 2021)

Klingenberg, S., Jørgensen, M. L. M., Dandanell, G., Skriver, K., Mottelson, A., & Makransky, G. (2020). Investigating the effect of teaching as a generative learning strategy when learning through desktop and immersive VR: A media and methods experiment. *British Journal of Educational Technology*, 51(6), 2115-2138. <https://doi.org/10.1111/bjet.13029>

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Yang, W., & Wang, X. (2021). Why do Generative Learning Strategy Improve Memory in VR? – Based on ICALM. *International Journal of Information and Education Technology*, 11(12), 646-650. <https://doi.org/10.18178/ijiet.2021.11.12.1576>



Hypotheses

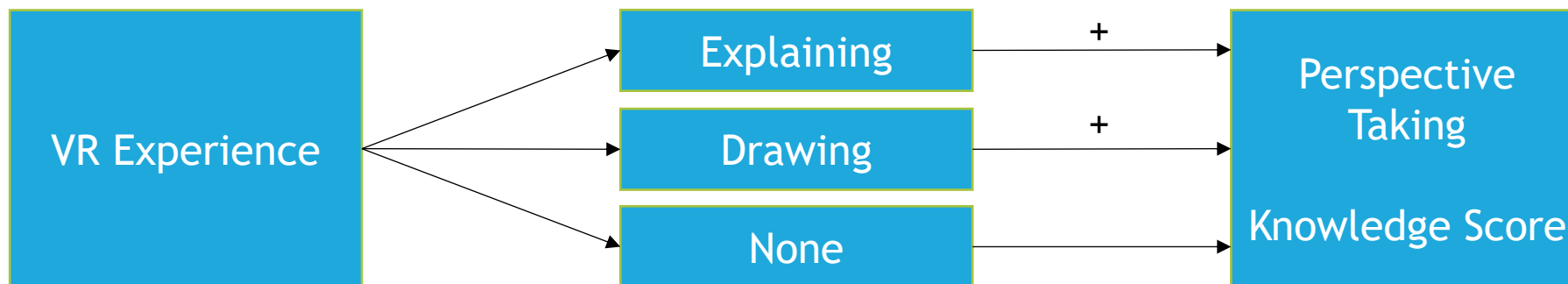
Theory

Method

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Discussion

- Generative learning activities that establish a connection to one's own person can particularly address affective learning objectives.
- H1: Groups who perform generative learning tasks will show higher perspective taking
- H2: Groups who perform generative learning tasks will show higher knowledge scores



Methods

Theory

Method

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Discussion

- 74 undergraduate students explore Anne Frank VR House
- 3 Conditions
 - Drawing
 - Self-explaining
 - No activity
- Measures
 - Perspective taking (Hartmann, 2008)
 - Knowledge test



Methods

Theory

Method

Results

Discussion

Versuchspersonencode: CZ 20

Aufgabenstellung:

Stell dir vor, du müsstest nur eine Woche unter den Bedingungen leben, unter denen Anne gelebt hat: sich versteckt halten, leise sein, nicht rausgehen ...

Wie würde sich das anfühlen? Womit hättest du die größten Probleme und was würde dich am meisten beunruhigen?

- entdeckt zu werden, weil wir/ich zu laut waren/
Unvorsichtig.
- Ich hätte Angst vor Platzangst, dass mir der Raum,
in dem wir uns bewegen dürfen, zu klein wird.
- Ich wäre traurig, dass ich meine Freunde und
andere Familienmitglieder (Tante, Onkel, Schwager etc.) nicht
mehr sehen kann.
- _____
- _____
- _____



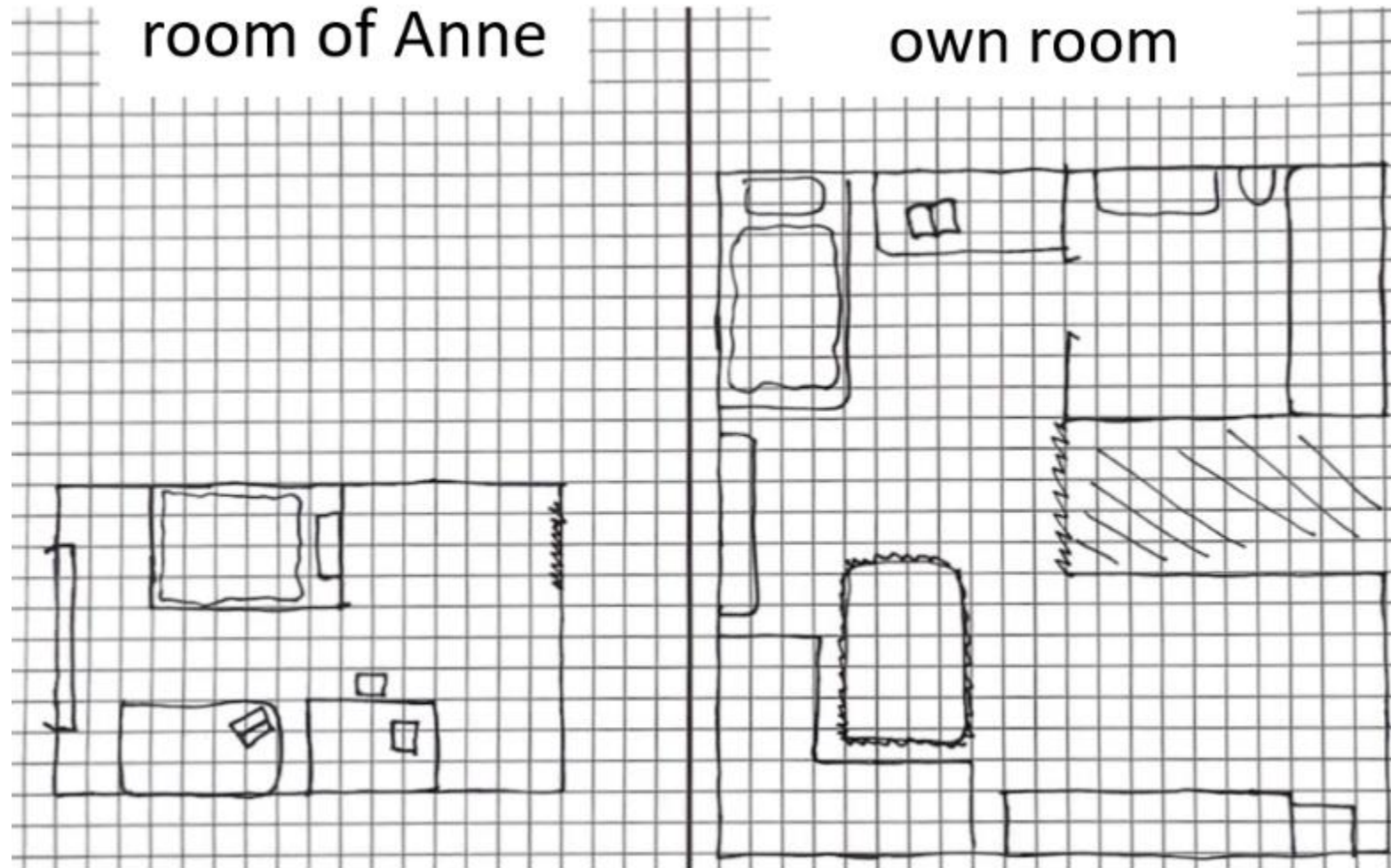
Methods

Theory

Method

Results

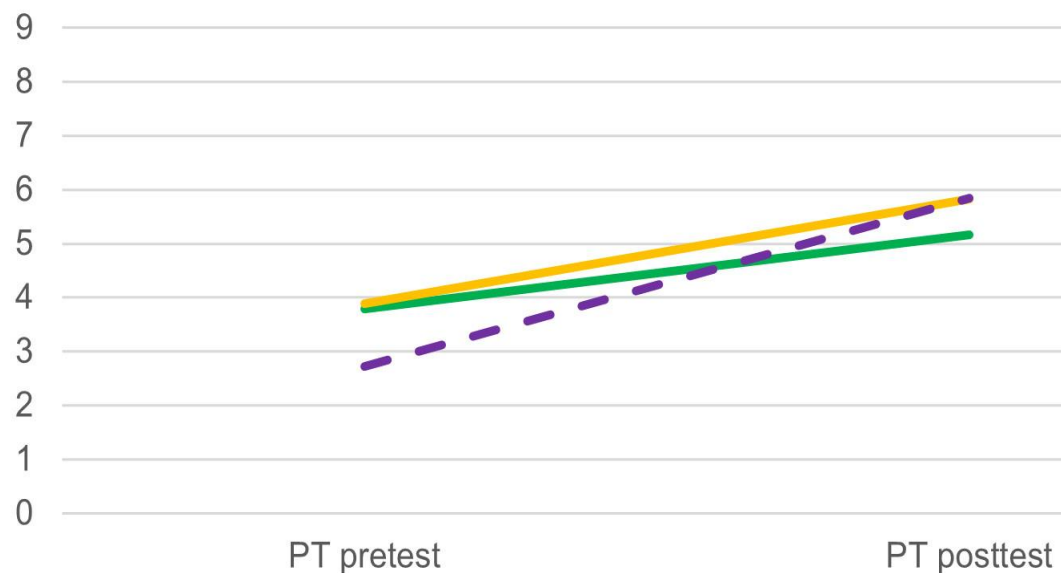
Discussion



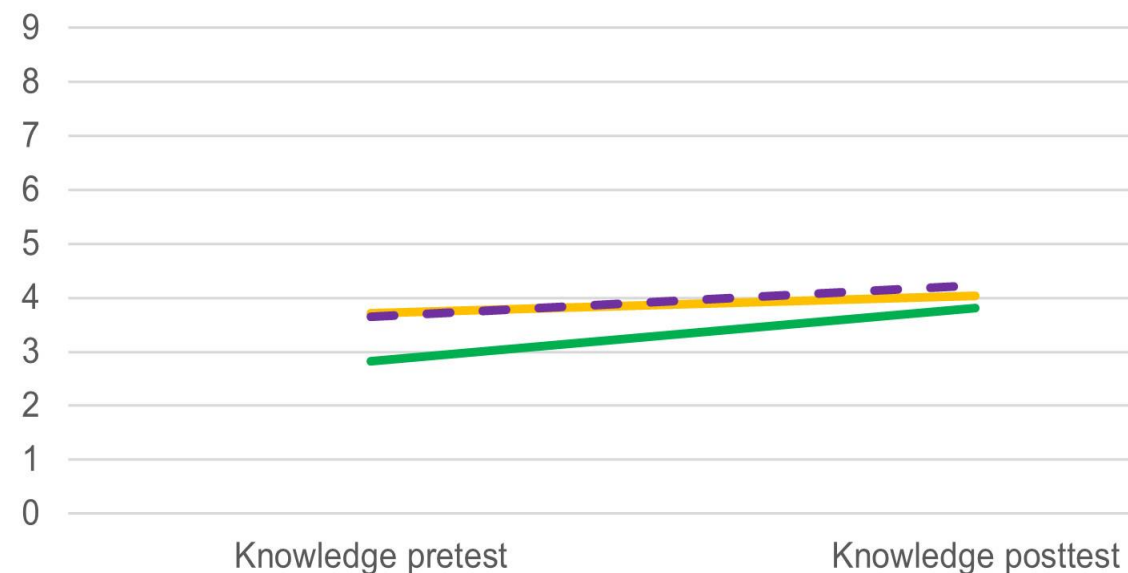
Results

Theory
Method
Results
Discussion

(a) Perspective Taking



(b) Knowledge



— Drawing — Explaining - - None



Results: Perspective Taking

Theory

Method

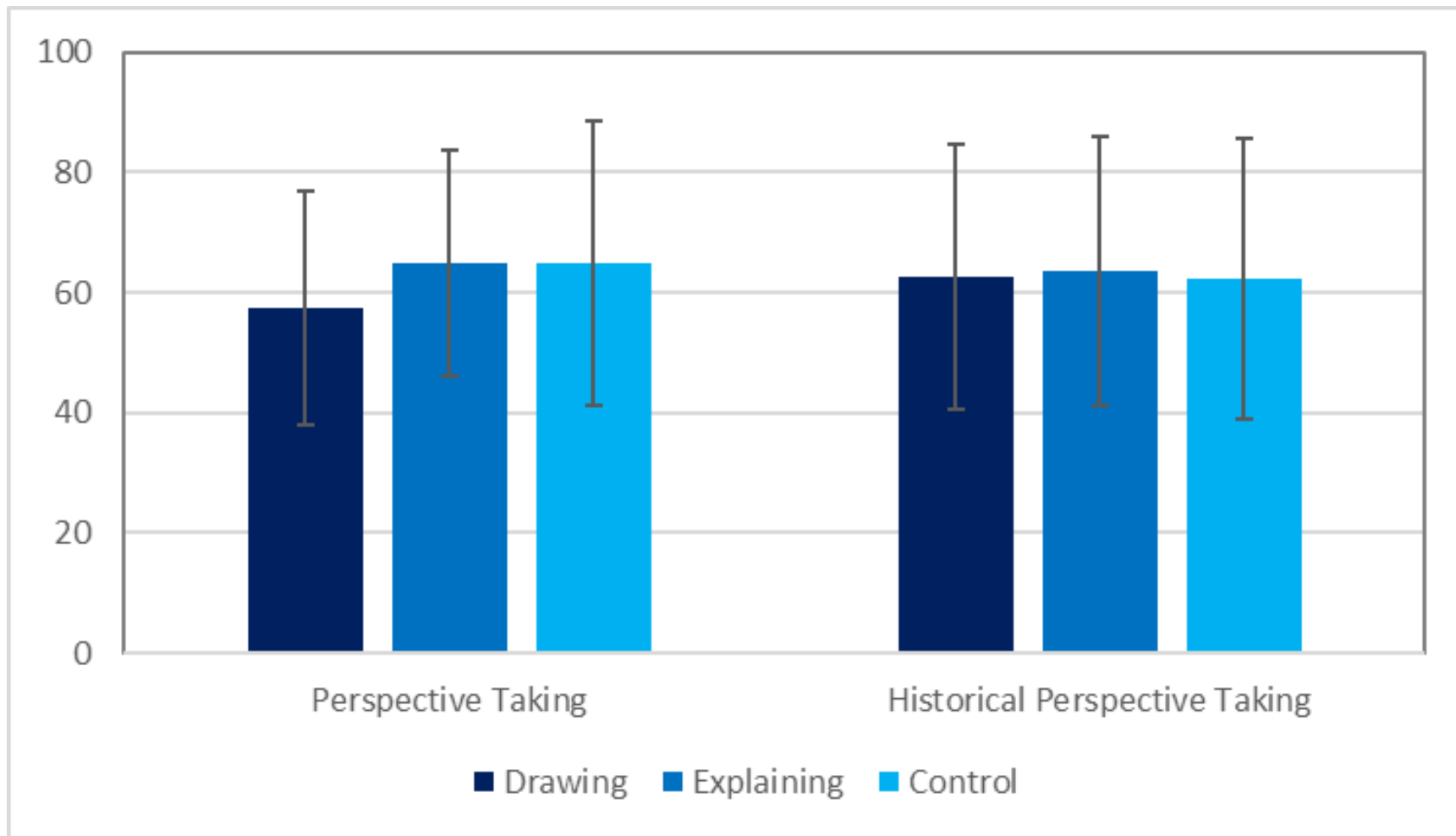
Results

Discussion

- Pre-Post comparison
 - Higher self-assessed perspective taking in all groups, $t(73) = 9.16, p < .001, d = 1.06$
 - Drawing: $d = 0.78$
 - Self-explaining: $d = 1.22$
 - Control: $d = 1.34$
- Between-group comparison
 - No group differences
 - $F(2, 71) = 0.82, p = .447$, Pillai's trace $V = 0.02$



Results: Perspective Taking



Theory

Method

Results

Discussion



Discussion

Theory

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Discussion

- We did not find additional value in generative learning tasks
- Still somewhat unclear which generative tasks are beneficial
- We found large effect sizes for perspective taking (pre-post comparison)



Limitations

Theory

Method

Results

Discussion

- Only short-term effects were investigated
- Difficult to manage cognitive load in VR (Albus et al., 2021)
- VR might have different effects in novice users (Jun, 2023)
- More reliable measures for perspective taking needed

Albus, P., Vogt, A., & Seufert, T. (2021). Signaling in virtual reality influences learning outcome and cognitive load. *Computers & Education*, 166, 104154.
<https://doi.org/10.1016/j.compedu.2021.104154>

Jun, Y. (2023). The Differential Effects of Virtual Reality (VR) on the Novice and Experienced VR Users. *Asia Marketing Journal*, 25(2), 61-70.
<https://doi.org/10.53728/2765-6500.1610>



Thank you!