Suitability of Immersive 2D Environments for Tertiary Education using the Gather Environment as an Example

Gerhard Hube[1], Kevin Pfeffel [2]

[1]Faculty of Economics and Business Administration
[2]Faculty of Computer Science and Business Information Systems
University of Applied Sciences Würzburg-Schweinfurt

Contact email: gerhard.hube@fhws.de

Porto, 30.06.2022

IARIA

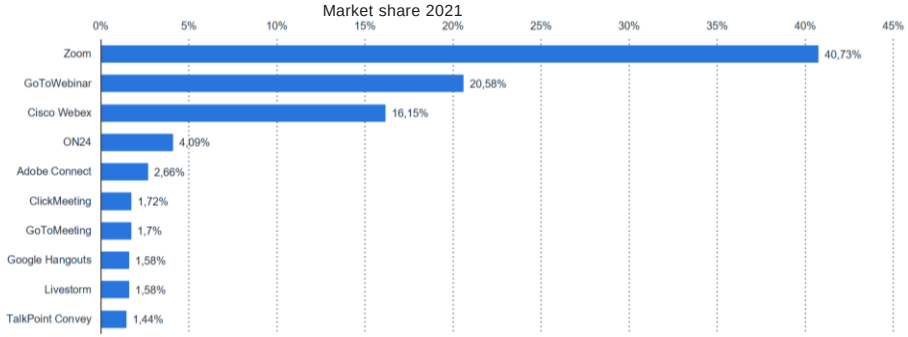
Prof. Dr.-Ing. Gerhard Hube

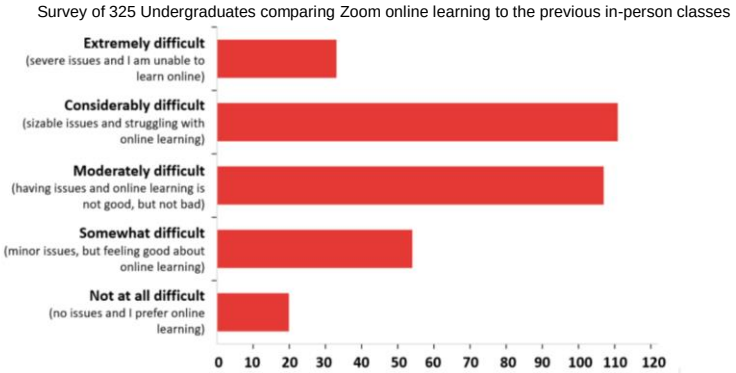
Professional and academic career

- Since April 2010 professor for “Strategic Innovation Management” and responsible for the Master Program of “Innovation for Small and medium companies”. Member of the committee for technology and research at the chamber of industry and commerce in Würzburg, director of digital business and future technology lab. Research on innovation management, future technologies and digitalization
- From 2006 to 2010 head of department “Market Intelligence & Future Technology" at Freudenberg company responsible for concept and implementation of the strategic innovation management in Europe.
- senior-scientist&consultant at Fraunhofer-IAO with the main focus in future technologies and knowledge management in an international context, doctoral thesis in 2005 about knowledge work and innovation management awarded with the Fraunhofer IAO innovations award
- product manager&consultant in an IT-startup enterprise until 2000
- diploma degree for mechanical engineering in 1995

I. Introduction

- Massive use of online teaching in almost every education level, mostly with video conferencing tools like zoom, GoToWebinar or similar tools [2]
- Due to time consuming and long during online university courses fatigue and weariness can be observed called „zoom fatigue“ [3]
- Nevertheless it is presumed that online will be continued because of several benefits in education but also in professional work [4]
- Therefore alternatives and supplements should be proven





I. Introduction

- There are several approaches to categorize virtual environments. Some distinguish beetween immersive and non immersive [1] [5]-[8], other suggest a three way division from immersive to semi immersive to non immersive [9]
- To classify the virtual learning environment (VLE) which is used in this study we suggest to distinguish the level of immersion from high immersion to non immersion as a kind of continuum, like other authors also do [10]-[12]

e.g. video conferencing-system like zoom

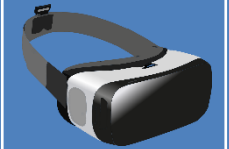
e.g. 2D desktop VR like gather.town

e.g. 3D desktop VR like second life

e.g. augmented reality like Microsoft Hololens

e.g. wide field displays or floor projections

e.g. head mount with smartphone like cardboards



e.g. head mounted displays like oculus

e.g.special designed rooms like a CAVE

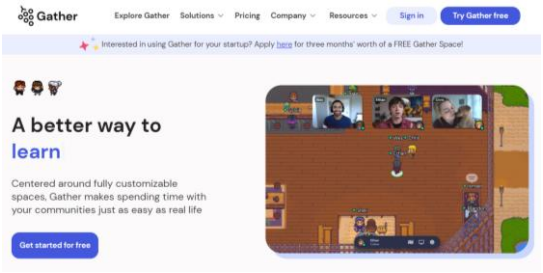
Non — level of immersion — high

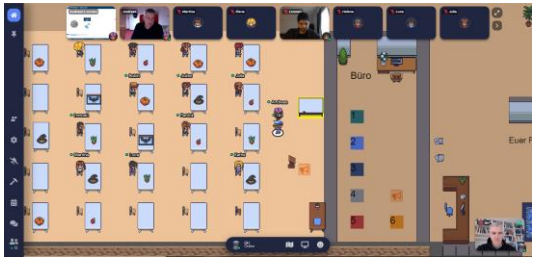
II. Related Work, Motivation

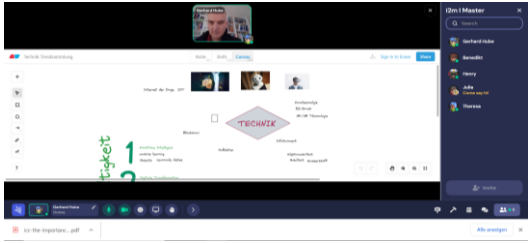
- Despite the high number of studies with high level VR application in education and the often positive results on learning success [13]-[15] the usability of this systems with HMD‘s within regular university courses does not seem to be suitable, because of technical, financial and health issues [8], [16], [17]
- Considering the specific requirements and accommodations for university lectures, desktop VR applications appear to be more suitable for online education [1] [18] [12]
- There is a need for more research on less immersive environments for education [19], also because of doubts about the context that higher immersion lead to better learning performance [11]
- Overall, there are several studies of desktop VR (D-VR) respectively VLE for specific topics, often computer science or medicine [17] [20]-[22]. These studies include various intensities of immersion, but still lack an evaluation of the overall and holistic suitability of 2D desktop learning environments for higher education, including the new immersive 2D environments that have appeared in the last three years

III. Method gather.town

- The software gather.town [23] was used as an immersive 2D desktop environment. This is a web conferencing software that allows to create a complete virtual replica of the teaching building.
- Podium:
  The podium is the classic teaching situation. Within the gather.town environment, all students and the tutor are in one large room. The tutor stands in front at the lectern, while the students take their places at the tables.
- Whiteboard:
  The whiteboard provides an opportunity for collaborative work. To do this, the whiteboard must first be activated. After that, all users who access the whiteboard at the same time can work together on it. This means that all users get write permissions and can interact with the whiteboard.

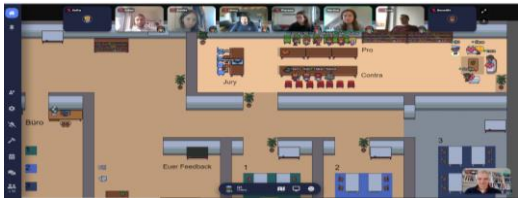


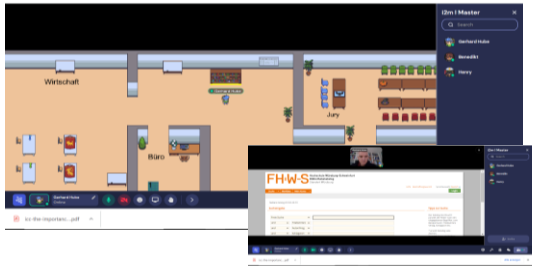




III. Method gather.town

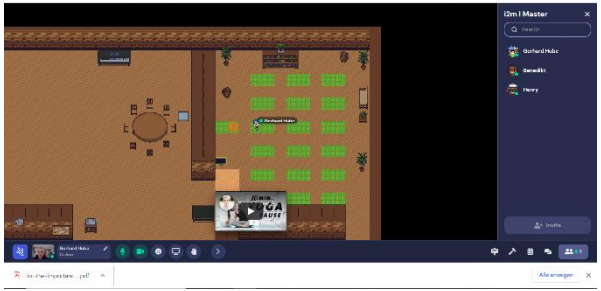
- Workshops:
  Workshops are smaller rooms that provide fewer seats than the large seminar rooms. Here, there are tables with seats and a whiteboard. Thus, the users have the possibility to do smaller group work.
- Group Discussion:
  This is a room that is designed in such a way that a pro and a con side can sit opposite each other and participate in a group discussion by means of the camera.
- Interactive objects:
  Within the environment, other interactive objects are stationed in the individual rooms or corridors. In the entrance area, for example, there is a blackboard on which the timetable can be viewed, and next door, there is a tutorial that once again describes the functionality of the gather.town environment in a video.





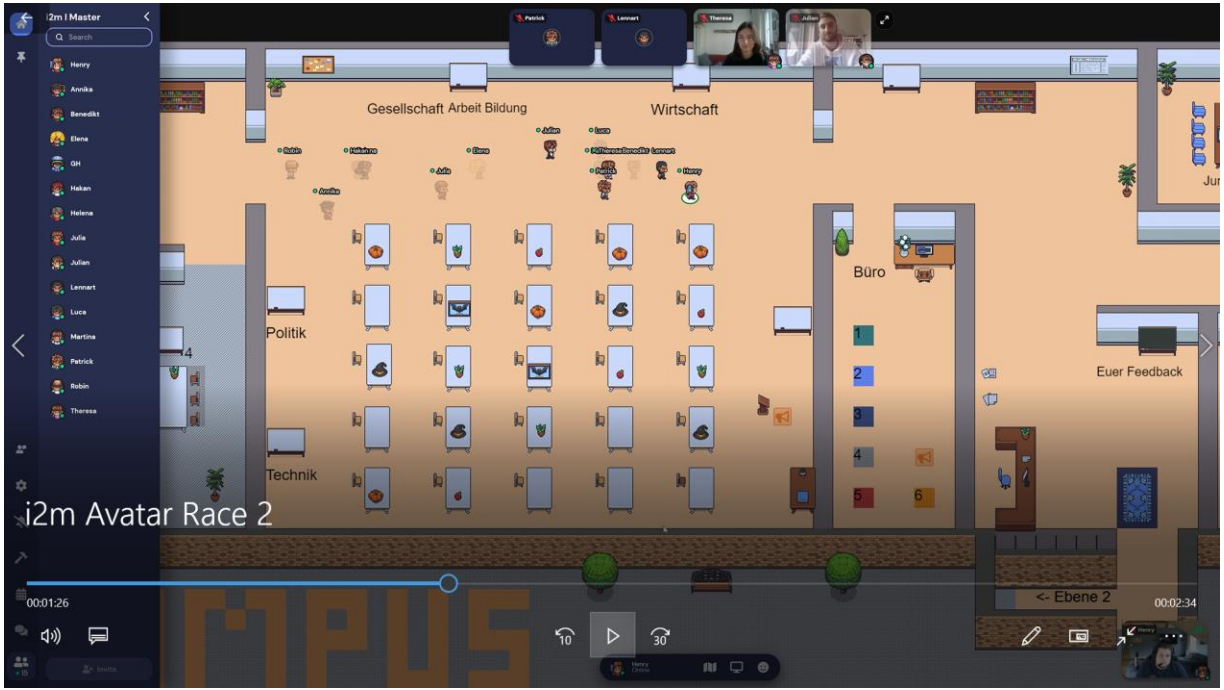
III. Method gather.town

- Break rooms:
  In the break rooms, users can stay between the individual seminars and have the opportunity to play various card games at a game table, making music or watching videos. In another break room, users have the opportunity to get on a yoga mat. A 10-minute instructional video is then played so users can join in on the yoga session from home.



III. Method gather.town

- Activation with “avatar race”:



IV. Measuring Instrument

- OLLES Questionnaire (modified 35-item form)
- Web-based survey instrument, used in online learning environments in tertiary education
- 7 Dimensions, 5-point Likert scale
  1. Student Collaboration (SC)
  2. Computer Competence (CC)
  3. Active Learning (AL)
  4. Tutor Support (TS)
  5. Information Design and Appeal (IDA)
  6. Material Environment (ME)
  7. Reflective Thinking (RT)
- Also computer use and internet use

V. Procedure & Sample

- Experimental Procedure
  - Introduction to gather.town and the OLLES Questionnaire (Original Language)
  - 4 measurement time points, within whole semester
  - First the seminar – Afterwards the questionnaire

- Sample
  - 16 valid subjects (1 was excluded because of extreme outlier values)
  - Only students from the University of Applied Sciences Würzburg-Schweinfurt within the seminar “trend analysis and innovation assessment” of the master study program “Innovation for small and medium Enterprises”
  - Average age is 24.44 years – minimum 22 years and maximum 30 years
  - 7 female and 9 male

VI. Results

- Was there a change in the evaluation with regard to the repetition of the use of the gather.town environment?

- Significant differences between measurement time point 3 and measurement time point 4
  - Dimension Student Collaboration (Exact Wilcoxon Test: z = -2.09, p = .037, n = 12)
  - and Material Environment (Exact Wilcoxon Test: z = -2.41, p = .016, n = 12)

- → no other significant differences between measurement time points

VI. Results

- Descriptive Analysis of the OLLES Questionnaire:

TABLE I.

Descriptive Analysis

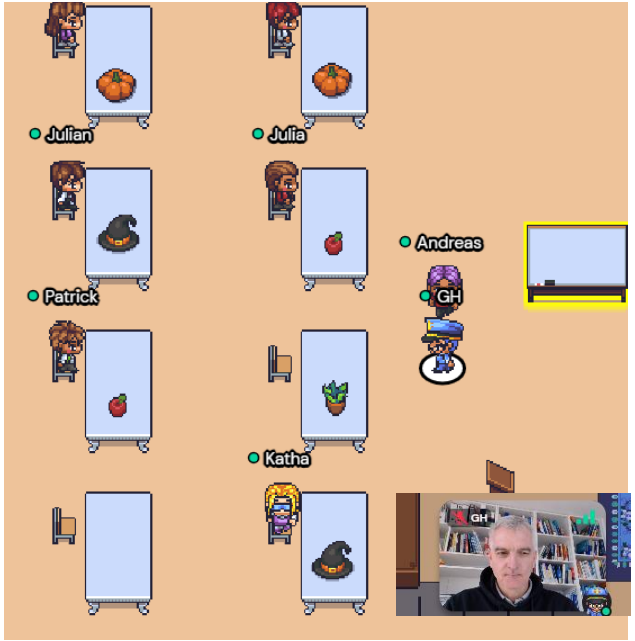
Dimension	*Mean Value*	*Standard Error of the Mean*	*Standard Deviation*	*Minimum Value*	*Maximum Value*
Student Collaboartion (SC)	3,76	0,11	0,42	3,10	4,60
Computer Competence (CC)	4,57	0,11	0,44	3,55	5,00
Active Learning (AL)	3,64	0,13	0,46	2,70	4,60
Tutor Support (TS)	4,10	0,12	0,55	3,20	4,80
Information Design and Appeal (IDA)	3,73	0,12	0,47	2,93	4,80
Material Environment (ME)	3,84	0,07	0,28	3,50	4,45
Reflective Thinking (RT)	3,19	0,16	0,62	2,25	4,10

VII. Discussion

- Computer Competence (CC) → mean value 4,57
  - highest score in the study
  - asks in particular about the assessed competence of one's own computer and Internet use and also the ability to solve minor problems oneself
  - All subjects use their computers daily or at least several times a week and also use the internet on a daily basis
  - supports the assumption that all subjects had more than sufficient technical skills to use the gather.town environment to its full extent

VII. Discussion

- Tutor support (TS) → mean value 4,1
  - Second highest score
  - asks in particular about the participation and accessibility of the tutor
  - response time to questions and feedback play an important role, good communication [30] and interaction [26] lead to positively perceived VLEs.
  - may be due to constant availability and timely communication, as the tutor himself was also always present and responsive within the environment. Therefore, from this perspective, the gather.town environment is well suited for interactive teaching



VII. Discussion

- Student Collaboration (SC) → mean value 3,76
  - asks in particular about the frequency of communication between students and includes the question of help and feedback as well as the mutual exchange of information and resources.
  - as several studies revealed collaboration and communcationds are important factors for learning [24] [25] [28] and have positive effects on users within a VLE.
  - It can be assumed that high values were achieved here in the evaluation, since gather.town provides enough possibilities, especially through the functions whiteboard, workshops, group discussion and informal encountering.

VII. Discussion

- Active Learning (AL) → mean value 3,64
  - specifically asks about the motivation created, as well as the feedback received through the activities or the teaching unit within the environment itself.
  - various studies already showed that motivation [27] [28] [29] is a crucial factor in the use of VLE's.
  - We assume that especially the varied design of the gather.town environment, but also the use of break rooms led to good scores on this dimension.

VIII. Conclusion

- All dimensions of the OLLES questionnaire reach high to very high scores

→ From a purely descriptive point of view, it can therefore be assumed that the gather.town environment is holistically suitable as a learning environment in the tertiary sector

→ No comparison group so far

- Daily Computer and Internet use and a sufficiently explained environment

→ No poor ratings for the environment due to possible lack of technical skills

- Repeated measurement of user ratings of the gather.town environment showed that there was virtually no difference.

→ A one-time survey after the first unit or even after the last unit is quite sufficient

IV. Future Work

1. Group comparison with the same lecture in next winter semester with classical video conferencing tool and running the same OLLES questionnaire
   → Possibility to compare the different VLE's in term of OLLES dimensions
2. Adding another questionnaire to measure the sense of presence
   → Checking if there is some specific feeling of presence and this affect using
3. Usage of additional subsequent interviews after lecture
   → To get additional important insights from participants, e.g. like usage of the VLE besides the lecture as we recognized while this study
4. Additional group comparisons with the same lecture and face to face teaching
   → Possibility to compare VLE lectures and face to face teaching
5. Extend the study with another lecture to evaluate some kind immersive VR environemt e.g. head mountain display, motion capture or wide screen technology
   → Posibility to compare within a broad range of immersion in tertiary education

Many thanks for your attention

X. References

1. J. Clayton, "Development and Validation of an Instrument for Assessing Online Learning Environments in Tertiary Education: The Online Learning Environment Survey (OLLES)," doctoral thesis at Curtin university, 2007, [Online]. Available from: https://espace.curtin.edu.au/handle/20.500.11937/550 2022.04.28
2. Datanyze, LLC: zoom, top competitors of zoom, [Online]. Available from: https://www.datanyze.com/market-share/web-conferencing--52/zoom-market-share 2022.04.28
3. E. Peper, V. Wilson, M. Martin, E. Rosegard, R. Harvey, "Avoid Zoom Fatigue, Be Present and Learn," International society for neurofeedback ans research ISNR, 2021. [Online]. Available from: https://www.neuroregulation.org/article/view/21206/13976 2022.04.28
4. S. Lund, A.Madgavkar, J .J. Manyika, S. S. Smit, K. Ellingrud, M. Robinson, O. Meaney, "The future of work after COVID-19," McKinsey Global Institute, 2021 [Online]. Available from: https://www.mckinsey.com/featured-insights/future-of-work/the-future-of-work-after-covid-19 2022.04.28
5. G. G. Robertson, S. K. Card, and J. Mackinlay, "Three views of virtual reality: nonimmersive virtual reality," Computer, 26(2), pp. 81, 1993. [Online]. Available from: https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=192002 2022.04.28
6. C. J. Chen, S. C. Toh, and M. F. Wan, "The theoretical framework for designing desktop virtual reality-based learning environments," Journal of Interactive Learning Research, 15(2), pp. 147.167, 2004.
7. Z. Merchant, E. T. Goetz, L. Cifuentes, W. Keeney-Kennicutt, T. J. Davis, "Effectiveness of virtual reality-based instruction on students' learning outcomes in K-12 and higher education: A meta-analysis," in: Computers & Education 70 pp. 29–40, 2014. [Online]. Available from: https://www.sciencedirect.com/science/article/pii/S0360131513002108 2022.04.28
8. D. Hamilton, J. McKechnie, E. Edgerton, and C. Wilson, "Immersive virtual reality as a pedagogical tool in education: a systematic literature review of quantitative learning outcomes and experimental design," in J. Comput. Educ. 8 (1), pp. 1–32, 2021. DOI: 10.1007/s40692-020-00169-2
9. A. F. Di Natale, C. Repetto, G. Riva, and D. Villani, "Immersive virtual reality in K-12 and higher education: A 10-year systematic review of empirical research," in: Br. J. Educ. Technol. 51 (6), pp. 2006–2033, 2020. DOI: 10.1111/bjet.13030
10. M. C. Johnson-Glenberg, H. Bartolomea, and E. Kalina, "Platform is not destiny: Embodiedlearning effects comparing 2D desktop to 3D virtual reality," STEM experiences Journal of Computer Assisted Learning, 37(5), pp. 1263–1284, 2021. https://doi.org/10.1111/jcal.12567
11. J. Zhao , T. Sensibaugh , B. Bodenheimer , T. P. McNamara , A. Nazareth , N. Newcombe , M. Minear and A. Klippel "Desktop versus immersive virtual environments: effects on spatial learning, Spatial Cognition & Computation," 2020. DOI: 10.1080/13875868.2020.1817925
12. M. N. Selzer, N. F. Gazcon, M. L. Larrea, "Effects of virtual presence and learning outcome using low-end virtual reality systems," Displays, vol. 59, pp. 9-15, 2019. ISSN 0141-9382, https://doi.org/10.1016/j.displa.2019.04.002.
13. N. Elmquaddem, "Augmented and virtual reality in education. Myth or reality?" International Journal of Emerging Technologies in Learning, 14(3), pp. 234–242, 2019. https://doi.org/10.3991/ijet.v14i03.9289
14. Y. Wu, Z. Yuan, D. Zhou, and Y. Cai, "A mobile Chinese calligraphic training system using virtual reality technology," AASRI Procedia, 5, pp. 200-208, 2013.
15. Y. Gao, V. A. Gonzalez, and T. W. Yiu, "The effectiveness of traditional tools and computer-aided technologies for health and safety training in the construction sector: A systematic review," Computers & Education, 138, pp. 101–115, 2019. https://doi.org/10.1016/j.compedu.2019.05.003

X. References

16. T. M. Porcino, E. Clua, D. Trevisan, C. N. Vasconcelos, and L.Valente, "Minimizing cyber sickness in head mounted display systems: Design guidelines and applications," in IEEE 5th International Conference on Serious Games and Applications for Health (SeGAH) pp. 1–6, 2017. doi:10.1109/SeGAH.2017.7939283 .
17. L. Freina, M. Ott, "A Literature Review on Immersive virtual reality in Education: State Of The Art and Perspectives," in: LE@D - Laboratório de Educação a Distância e Elearning | Artigos em revistas / Papers in journals, [Online]. Available from: https://www.researchgate.net/publication/280566372_A_Literature_Review_on_Immersive_Virtual_Reality_in_Education_State_Of_The_Art_and_Perspectives 2022.04.28
18. H.-M. Huang, U. Rauch, and S.-S. Liaw, "Investigating learners' attitudes toward virtual reality learning environments: based on a constructivist approach," Computers & Education, 55(3), pp. 1171-1182, 2010.
19. D. Beck, L. Morgado, P. OShea, "Finding the Gaps about Uses of Immersive Learning Environments: A Survey of Surveys in: Journal of Universal Computer Science, vol. 26, no. 8, pp. 1043-1073, 2020. [Online]. Available from: https://repositorioaberto.uab.pt/bitstream/10400.2/10070/1/jucs_26_08_1043_1073_beck.pdf 2022.04.28
20. I. R. Boer, P. R. Wesselink, and J. M. Vervoorn, "Student performance and appreciation using 3D vs. 2D vision in a virtual learning environment," in: European Journal of Dental Education 20 (3), pp. 142–147, 2016. DOI:10.1111/eje.12152.
21. B. Wainman, G. Pukas, L. Wolak, S. Mohanraj, J. Lamb, G. R. Norman, "The Critical Role of Stereopsis in Virtual and Mixed Reality Learning Environments," in: Anatomical Sciences Education 13 (3), pp. 401–412, 2020. DOI:10.1002/ase.1928.
22. Y.-P. Chao, H.-H. Chuang, L.-J. Hsin, C.-J. Kang, T.-J. Fang, H.-Y. Li, C.-G. Huang, T. Kuo, C. Yang, H.-Y. Shyu, S.-L. Wang, L.-Y. Shyu, and L.-A. Lee, "Using a 360° virtual reality or 2D Video to Learn History Taking and Physical Examination Skills for Undergraduate Medical Students: Pilot Randomized Controlled Trial," JMIR Serious Games. 9. e13124. 10.2196/13124, 2021.
23. Gather Presence, Inc. (2022). gather.town. [Online]. Available from https://www.gather.town 2022.04.28
24. S. Mystakidis, E. Berki, J. Valtanen, "Deep and Meaningful E-Learning with Social virtual reality Environments in Higher Education: A Systematic Literature Review," MDPI, Appl. Sci. 2021, 11, 2412. [Online]. Available from: https://doi.org/10.3390/app11052412 2022.04.28
25. D. Kim, D. Jo, "Effects on Co-Presence of a Virtual Human: A Comparison of Display and Interaction Types," in: Electronics 2022, 11, 367. [Online]. Available from: https://doi.org/10.3390/electronics11030367 2022.04.28
26. R. Charanya, M. Kesavan, "Analysis of Factors Influencing the Virtual Learning Environment in a Sri Lankan Higher Studies Institution," 2019 International Research Conference on Smart Computing and Systems Engineering (SCSE), 2019. DOI: 240-244 https://ieeexplore.ieee.org/document/8842719
27. S. Y. Chien, G. J. Hwang, and M. S. Y. Jong, "Effects of peer assessment within the context of spherical video-based virtual reality on EFL students' English-Speaking performance and learning perceptions," Computers & Education, 146, 103751, 2020.
28. M. H. Kim, "Effects of Collaborative Learning in a Virtual Environment on Students' Academic Achievement and Satisfaction," Journal of Digital Convergence, 19(4), pp 1–8, 2021. https://doi.org/10.14400/JDC.2021.19.4.001.
29. B. Yildirim, E. Sahin-Topalcengiz, G. Arikan, and S. Timur, "Using virtual reality in the classroom: Reflections of STEM teachers on the use of teaching and learning tools," Journal of Education in Science, Environment and Health (JESEH), 6(3), pp. 231-245, 2020. DOI:10.21891/jeseh.711779
30. I. Reisoğlu, B. Topu, R. Yılmaz, T. K. Yılmaz, Y. Göktaş, "3D virtual learning environments in education: a meta-review," in: Asia Pacific Educ. Rev. 18 (1), pp. 81–100, 2017. DOI: 10.1007/s12564-016-9467-0

X. References - Illustration

Slide 4

1. https://pixabay.com/de/illustrations/webinar-conferencing-video-5310229/
2. Own illustration using gather.town
3. https://secondlife.com/
4. https://pixabay.com/de/photos/hololens-holo-linse-1330225/
5. https://www.mth-potsdam.de/en/blog-en/led-wall-instead-of-green-screen-virtual-production-reinvents-the-film-world/
6. https://pixabay.com/de/photos/google-karton-3d-vr-2202220/
7. https://pixabay.com/de/vectors/virtuell-realit%c3%a4t-spiel-brille-2055227/
8. https://reportage.wdr.de/vr-in-der-wissenschaft#22863

Suitability of Immersive 2D Environments for Tertiary Education using the Gather Environment as an Example

Gerhard Hube[1], Kevin Pfeffel [2]

[1]Faculty of Economics and Business Administration
[2]Faculty of Computer Science and Business Information Systems
University of Applied Sciences Würzburg-Schweinfurt

Contact email: gerhard.hube@fhws.de

Porto, 30.06.2022

IARIA